Capgemini invent | AUTONOMY
WORLD'S LEADING MOBILITY NETWORK

GETTING TO NET ZERO: THE WAY FORWARD FOR THE MOBILITY ECOSYSTEM

SUMMARY

EXECUTIVE SUMMARY

The mobility sector is one of the most emission intensive sectors (accounting for 20% emissions worldwide) and a key target of the sector's strategy is to reach net zero emissions by 2050. More recently, the COVID-19 crisis provided a picture of what the world could look like as a result of greenhouse gas emission reductions from the transport and mobility sectors. This only further boosts the need to reduce emissions and decarbonize the majority of transport modes, particularly as they relate to the mobility of people.

Decarbonization in the mobility sector can only be achieved if there is a strong focus on value chain emissions. These emissions are often representative of the majority of an organisation's total carbon footprint. Despite the challenge in doing so, decarbonizing the value chain presents a huge untapped opportunity for climate action by enabling companies who have a relatively small direct emission footprint to have a significant impact on a global scale. To address this, the mobility ecosystem must work together with **two key stakeholders in decarbonizing the sector: public and energy actors**. However, presently the mobility sector still depends heavily on fossil fuels. In order to accelerate the move towards sustainable mobility and achieve a net zero transition, **a major shift in investment and business models is required, as well as a legal framework for sustainable mobility that is supported by a conducive policy environment**.

So what exactly can drive net zero? In this Point of View, we have proposed the **SIMEC Net Zero Framework**, which focuses on **shared mobility solutions, intelligent technology, multimodal mobility, eco-powered and circular economy** systems. In order to reach net zero, each actor in the ecosystem needs to make a transition:

- (i) **Consumers** need to be incentivized in changing their mobility behaviour through eco friendly initiatives.
- (ii) **Mobility providers and operators** are responsible for fostering green innovation and services.
- (iii) **Corporates** can play a significant role in accelerating the adoption of low carbon alternatives through their employees' mobility habits and patterns.
- (iv) **Governments and local public authorities** must take a systemic approach to accelerate the progress towards net zero emissions, for instance by allocating a dedicated part of the budget to finance climate change and sustainable mobility projects.

In an analysis of the mobility of people's current state of play and predictive changes, this paper assesses the current and future role of mobility to contribute to a net zero future. We have conducted a survey with 45+ companies and government authorities to understand their challenges and expectations on the Net Zero Mobility Emission Road:

- **over 75% of the respondents had put initiatives in place, with the majority of the initiatives being shared mobility oriented**;
- **legal, investment and collective and systemic prerequisites are needed** to implement a net zero transition across the mobility sector;
- **a lack of ecosystem cooperation and budgetary constraints** represent the greatest obstacles preventing the implementation of more green projects within their organisations.

Despite the mobility sector being one of the slowest sectors to decarbonize, while still contributing to some of the largest shares of emissions at the global level, there are some promising initiatives and strong shifts in behaviour from the mobility ecosystem that are increasingly more noticeable.
The future of the mobility ecosystem will lie in mobility providers and operators increasingly fostering green innovation and services with the support of consumers, government regulation and corporations.

INTRODUCTION

The latest research has never been clearer: to avoid catastrophic climate crisis, current levels of global greenhouse gas (GHG) emissions will need to be cut in half by 2030 and reach net-zero by mid-century. But **what exactly does net-zero mean?**

There are two broad approaches: reducing GHG emissions, while also counterbalancing emissions with the removal of GHGs from the earth's atmosphere. As there are natural processes that continue to remove carbon from the atmosphere, net zero seeks to aid these processes by reducing as much as possible the addition of GHGs in the atmosphere. Under the scope of net-zero, the Greenhouse Gas Protocol – the most widely used GHG accounting system – divides emissions into 3 different categories:
Scope 1: emissions caused directly by an organization's activities - i.e. on-site fuel combustion
Scope 2: indirect emissions resulting from an organization's energy consumption - i.e. electricity use
Scope 3: other indirect emissions resulting from an organization's upstream - i.e. purchased goods and services: **or downstream** - i.e. use of sold products and activities

In comparison to carbon neutrality, or those efforts to balance out GHG emissions by offsetting – or removing from the atmosphere – an equivalent amount of carbon for the amount produced, net-zero offers a more complete approach to addressing emissions. Where carbon neutrality does not require an organization to set any kind of cap or limit to their GHG emissions, **net zero requires both upstream and downstream efforts** to reduce as much as possible the quantity of GHGs resulting from an activity. Where carbon neutrality aims for a correction of GHGs already emitted, net zero seeks to limit emissions from the beginning so that less carbon needs to be counterbalanced or offset.

Encouraged by governments, sustainable development and carbon reduction strategies have skyrocketed to the top of leaders' and companies' agendas. Nevertheless, mobility remains a fundamental pillar of our economy, and continues to represent a significant share of greenhouse gas emissions. The figures speak for themselves: mobility and transportation account for about 20% of emissions worldwide, 25% at the European level, and 30% in France.[1] The transportation sector has not seen the same gradual decline in emissions as other economic sectors, as it is 97% fossil fuel-powered and remains the least diversified of all energy end-use sectors.[2] One key reason for the slow speed of emissions reductions in mobility and transportation has been the lack of readily available and affordable alternatives to internal combustion engine (ICE) vehicles. With 75% of transportation emissions dominated by road transportation,[3] reducing manufacturers' reliance one ICE vehicles will be crucial.

1. French Ministry for an Ecological and Solidary Transition, June 2019; European Union
2. SLOCAT, Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonization, Transport and Climate Change Global Status Report – 2nd edition, 2021
3. Our World in Data, Cars, Planes, Trains: Where do CO2 Emissions in Transport Come From?, 2020

Despite the sector's overall slow progress in terms of emissions reductions, we have observed that significant progress has been made in the introduction of sustainable mobility initiatives and alternatives – particularly the mobility of people. Today, the mobility industry is dominated by strategies that are prioritizing solutions like smart traffic management systems, the electrification of fleets, alternative transportation fuels, Mobility as a Service, and other smart applications and technologies that encourage the shift to lower-emission transportation modes, more efficient systems, and alternative energies. Institutional actors, governments, and private players alike are beginning to seriously engage with low-emissions mobility strategies. In 2019, France released its most ambitious mobility reform yet, with the EU's Sustainability and Smart Mobility Strategy following suit in 2020. Hand-in-hand with political commitments, a range of private mobility operators and service providers have pledged to achieve their own net-zero targets by 2030 (Two interesting examples are FREE NOW and Lime). Under the framework of a survey conducted specifically for this paper, **over 75% of respondents have set a target for contributing to net zero mobility** (see figure 1 and 2). Yet will these initial strategies be sufficient to achieve zero emission mobility? Thus far, the data shows that sectoral efforts have not been able to significantly close the emissions gap. Achieving net-zero by 2050 will require a new framework of action.

Figure 1 - Has your organisation set a target for reducing its emissions?

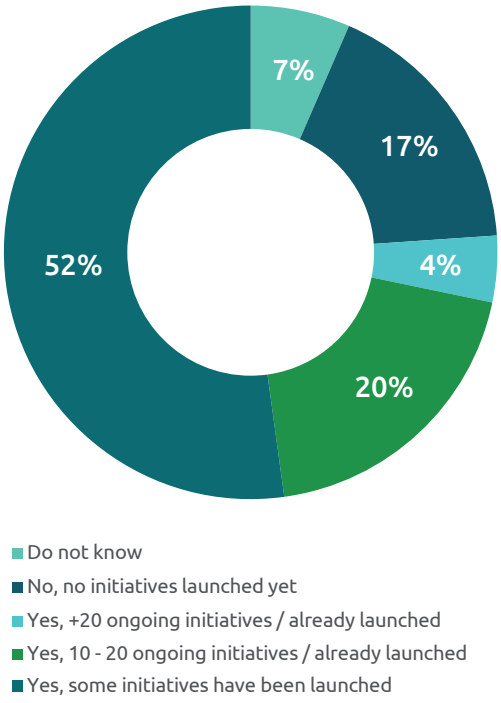
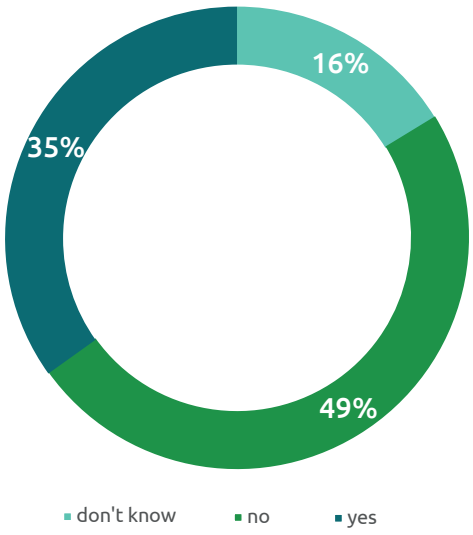


Figure 2 - Has your organisation integrated carbon offsetting initiatives?



4. Capgemini and Autonomy Survey, Net Zero Mobility Emission Survey, 46 answers, 2021

1 MOBILITY AS A CORNERSTONE OF THE CLIMATE CHANGE STRATEGY: WHERE DO WE STAND AND WHAT NEEDS TO CHANGE?

1-1 Baseline

Around the world, legacy transportation systems limit progress towards a more sustainable future. There are significant hurdles due to the way these systems are designed, as well as a small range of available sustainable transportation options across countries. In urban areas especially, increasing resource consumption has led to an excessive use of personal vehicles and a rising number of trips taken by airplanes in recent years. By 2050, it is expected that the global urban passenger mileage will double across all modes. At the moment though, there is a slight reversal in this upward trend. Despite the increasing consumption of resources and projections of growing emissions from the transportation sector, the ongoing COVID-19 pandemic has temporarily decreased emissions as a result of people's reduced mobility.

1-2 Impact of COVID-19

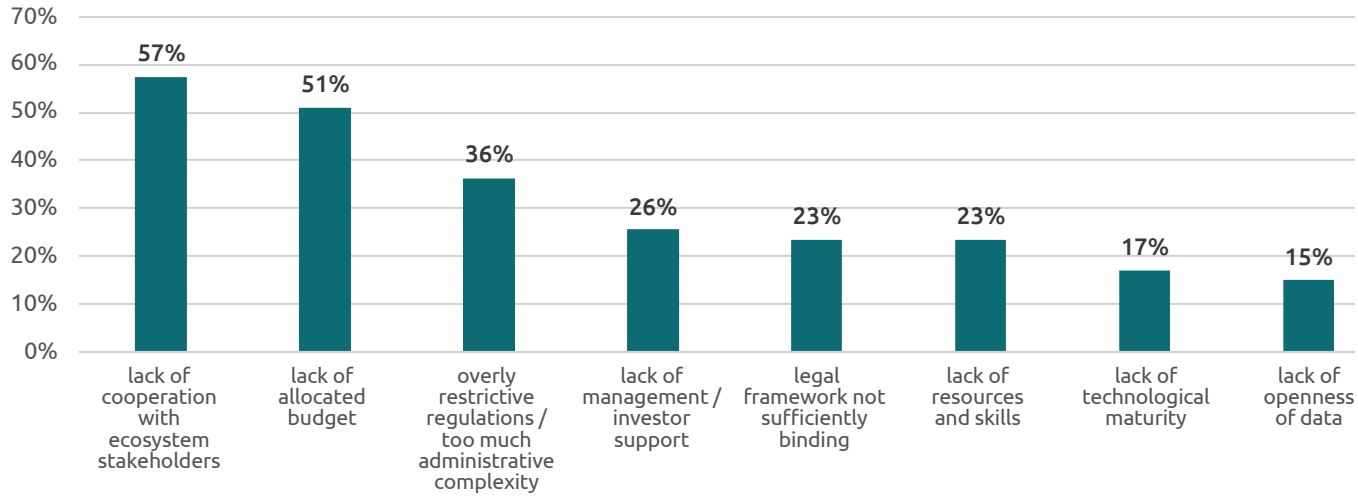
The COVID-19 crisis resulted in a decline in emissions across sectors in 2020, especially in the transportation and mobility sectors. The forced restriction of people's daily commute to work and the consequent economic recession were both factors that contributed to an 8% decline in CO2 emissions in 2020, compared to 2019[5]. On the other hand, there was also a global rise in private vehicle ownership and a decline in shared mobility and shared pooled MaaS services. **Individual use of transportation vehicles were both negative and positive, with more people opting to use their personal cars, but also bicycles, or simply walking more often in place of taking public transportation.**

For instance, in the U.S., walking as a mobility option increased by 14%[6]. Similarly, according to data pooled together by the European Cycling Federation, there was a spike in the number of people cycling across the EU in 2020, as well as an increase in investments for cycling infrastructure[7]. It was observed that the provision of cycling infrastructure was a driving force behind higher rates of adoption across the population, and governments quickly began to prioritize these efforts[8]. For example, the Ile-de-France region in France announced in 2020 that there would be an investment of 300 million euros in permanent and temporary cycle lanes across the region[9, 10]. However, as lockdowns were lifted across different parts of the world and industries began to recover, by December 2020, global CO2 emissions were actually 2% higher than in December 2019, just before the start of the pandemic. Thus, CO2 emissions post-lockdown were higher than those recorded before the crisis began, thereby negating some of the positive ecological impacts mentioned above[11].

1-3 Collective & systemic levers for net zero transition

According to national projections in Europe, by 2030, greenhouse gas emissions from transportation will decrease only slightly from current levels, remaining higher than 1990 levels. Our survey among 40+ companies and government authorities shows that legal, investment and collective and systemic prerequisites are needed to implement a net zero transition across the mobility sector[12].

Figure 3 - Main obstacles to the implementation of Net Zero emission initiatives within your organization



5. IEA, Global Energy Review: CO2 Emissions in 2020
6. World Economic Forum, Why the Future of Sustainability Starts with Mobility, 2021; IEA, Press Release, 2021
7. European Cycling Federation, Is the COVID-19 cycling boom real?, 2020
8. PNAS, Provisional COVID-19 infrastructure induces large, rapid increases in cycling, 2021
9. Le Parisien, L'Ile-de-France va investir 300 millions d'euros pour la réalisation du RER vélo, 2020
10. Cyclist, Paris pumps €300m into cycling infrastructure during coronavirus, 2020
11. IEA, After steep drop in early 2020, global carbon dioxide emissions have rebounded strongly, 2021
12. Capgemini and Autonomy Survey, Net Zero Mobility Emission Survey, 46 answers, 2021

1-4 The value chain: the urgent need for decarbonization

While the COVID-19 crisis only led to a temporary decrease in emissions, it did provide a picture of what the world could look like as a result of greenhouse gas emission reductions from the transportation and mobility sectors, amongst others[13]. This further supports the need to reduce emissions and decarbonize the majority of transportation modes.

Decarbonization involves targeting scope 1, 2 and 3 emissions. Scope 3 emissions are especially important in the decarbonization of the mobility sector, and are also referred to as value chain emissions. Value chain emissions often represent the majority of an organisation's total GHG emissions[14]. For example, in the case of the automotive industry, scope 3 emissions are included in the production of steel used in a car that an automotive original equipment manufacturer (OEM) produces. Scope 3 downstream emissions cover transportation of products, usage of sold products and product disposal. For an automotive OEM, this refers to the emissions from the cars driven by customers.

Decarbonizing value chain emissions is an essential step across sub sectors within the mobility industry, however it is a complex and difficult task to achieve. There are three key challenges:

1. While setting the baseline of scope 3 emissions and quantifying the value at stake, there could be a lack of carbon accounting foundations and an over reliance on secondary data for scope 3 emissions.

2. Add fullstop developing a carbon abatement cost curve to prioritize the pathway and set targets, there is likely to be significant uncertainty over cost and technical feasibility over carbon reduction levers.

3. Lastly, requiring industry wide collaboration to address many sources of emissions and needing sustained engagement by both internal and external stakeholders can be difficult[15].

However, despite these challenges, value chain decarbonization still presents a huge untapped opportunity for international climate action.

1-4-1 Changes within the ecosystem

Hand in hand with the need for rapid decarbonization – in combination with other long-standing challenges such as congestion, end-to-end integration, inefficiency, access and high prices – the mobility ecosystem has undergone significant disruptions in recent years. Accelerated by these environmental, social, and economic changes, the traditional automotive value chain is no longer driving the greatest demand in the industry[16]. New forms of mobility promise to better tackle the above challenges as the incursion of other industries into the mobility sector – particularly tech and big data – has shifted the focus from direct sales to more service-based products. Additionally, public sector actors and cities have become more integral to the mobility ecosystem as essential collaborators, given trends like increases to the regulation of personal vehicle travel, the use of public data to improve transportation systems, and the introduction of further decarbonization policies such as low-emissions zones. Like many other industries, changing consumer needs have also greatly shifted the industry's priorities: much more emphasis has been placed on shared economy principles with younger generations, and **69% of customers state that automotive product sustainability is important in their purchase decision, and 79% stating they would pay a premium for a more sustainable option**[17].

With the entry of many new players and markets within the mobility sector, these disruptions have been characterized by technological innovation and a stronger emphasis on data, digitalization, and software solutions rather than mechanics. At the heart of this new mobility ecosystem is the progressive distancing from a traditional vehicle-centric approach, towards one that places the user experience at its core. Such a shift in thinking has catalyzed more collaboration between mobility actors, as new trends – i.e. connectivity or Mobility as a Service – will require a more integrated approach where experts in different areas of mobility work together to create a final product. This has resulted in a more complex constellation of mobility actors that are further interconnected across different products, services, and specialities. Given these changes, many stakeholders will have to strike a balance between prioritizing their core business, new revenue streams, and new business models. Those players who are able to adapt to the ecosystem's changes and spread their core and secondary activities across multiple value chains will see the greatest success.

13. Nature, Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement, 2020.
14. Environment Protection Agency, Scope 3 inventory guidance.
15. McKinsey & Company, Making supply chain decarbonization happen, 2021.
16. European Commission, Smart Mobility European Value Chain Analysis and Workshop Report, 2018.
17. Capgemini Research, Sustainability Customer Experience in the Automotive Industry, Survey on 1,500 participants from UK, Germany, & the USA, November 2020.

1-4-2 Business models: a shift in responsibility?

To achieve a net zero transition, early-stage investment and funding are not sufficient; a major shift in investment & business models is required.

In terms of investment, several countries have implemented strong incentives towards:

- **Citizens**: incentives for promoting new mobility use, such as repairing old cycles in France, launched in 2020[18].
- **Companies**: several countries such as France, the UK, Italy or the US have implemented energy saving certification programs. These programs are mainly designed to achieve carbon-reduction objectives, and the mobility of people is only one part of them. They would need to be adjusted to integrate net zero emission definitions and prerequisites.
- Post-covid recovery plans, as mentioned previously.

Regarding business models, the net zero transition requires **a shift in terms of responsibility**. Business models of vehicle manufacturers have long relied on a "sell-in / sell-out" approach, in which the risk for maintenance and repairs is transferred to retailers and car owners. The net zero transition requires a shift towards a more sustainable engagement model, in which the manufacturer builds a model to address an extended product life cycle. For instance, every vehicle component will need to be monitored throughout the vehicle lifetime, entailing a switch from equipment warranty to usage warranty. New rules need to be defined on how the business value or safety homologation are shared, including who owns the data. The stakeholders (and the vehicle manufacturer especially) will have to manage hard and soft interfaces; future norms will need to integrate expected retrofit operations during the whole life cycle.

1-4-3 The legal framework: a conducive environment for creating policy

The United Nations have set the global ambitions

The United Nations have defined 17 global Sustainable Development Goals to guide all UN members in taking urgent actions for sustainable development. None of them is specifically focused on transportation, however, several of them rely on sustainable mobility, such as sustainable cities and communities (SDG 11), good health and well being (SDG 3), and industry, innovation and infrastructures (SDG 9). It's a call to action for every UN member.

The EU is setting the legal framework for sustainable mobility in Europe

In December 2020, the European Commission set a sustainable and smart mobility strategy[20] and a roadmap towards a 90% reduction of transportation GHG emissions by 2050. This roadmap indicates the ambition and concrete milestones for future policy, such as:

- By 2030, 100 European cities will be carbon neutral, at least 30 million zero-emission vehicles will be on the road, automated mobility will be used at large scale.
- By 2050, almost all road vehicles will be carbon neutral.

18. https://www.gouvernement.fr/profitez-du-coup-de-pouce-velo-reparation
19. The World Bank, Electrification of Public Transport , 2021
20. The European Commission, https://ec.europa.eu/transport/sites/default/files/2021-mobility-strategy-and-action-plan.pdf, 2021

The Shenzhen Bus Company Business Model

The Shenzen Bus Company (SZBG) used a financial leasing model that introduced a financial leasing company. That leasing company could purchase and own the vehicles and lease them to SZBG. The bus operating company then took ownership of the vehicles after the leasing period was over. Since the leasing period is equivalent to the total life of the buses, this particular arrangement can turn a high cost procurement into an easier annual rental or lease payment. For its electrification process it has two business models :

- The bus battery separation lease mode, at an early stage. The SZBG acquired the battery and the vehicle separately to minimize the operational and financial risks of battery deficiency. This model worked in overcoming financial barriers by shifting financial risks to financiers, charging service providers and vehicle manufacturers.
- A whole vehicle lease model, at a later stage. The SZBG established a viable model where players with different specializations were responsible for the businesses of their own expertise, while bearing any risks they were best positioned to deal with. The buses and batteries were owned by the financial leasing company with a lifecycle warranty for any key parts offered by bus manufacturers, then the charging facilities were owned by the owner of depots (this could be SZBG or a charging operator). Finally the charging service provider and the SZBG fleet operators were able to focus on the operation and management of the charging facilities and the bus fleet respectively[19].

On July 14th 2021, the European Commission went further and adopted additional measures as a part of the European Green Deal, an ambitious plan to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Within this plan, the European Commission sets a legal framework and 2030 goals for sustainable mobility:

- Targets for electric recharging infrastructure dedicated to light-duty and heavy-duty vehicles, for hydrogen recharging infrastructure of road vehicles[21].
- Strengthened CO2 emissions reduction requirements for new passenger cars and new light commercial vehicles[22].

European countries and cities have to set concrete rules to achieve these ambitions

To make these ambitions a reality, European countries and cities have to set a legal framework that will enable the promotion and development of new mobilities and infrastructures.

Thus far, national and local regulations have typically not been able to keep pace with the development of new mobilities. For example, insurance regulation for carsharing appeared a few years after the first car sharing services, cities were suddenly overtaken by the deployment of free-floating scooters just 2 years ago, and there are still some unclear rules for the use of sidewalks and roads for micro-mobility vehicles. One of the next challenges is to regulate the individual accountability of mobility users, especially as we move towards Mobility as a Service: how to help mobility service providers prevent the degradation of vehicles or destructive behaviors while using free-floating vehicles?

National authorities are also struggling with the deployment of electric vehicles and charging infrastructure. It is still unclear where charging stations should be located, who is responsible for their installation, and who is paying for the electricity, especially in private buildings or for corporate electric vehicles.

Political sponsorship is one of the main drivers for mobility trends to become reality. For example, the city of Paris has set a harsh policy on cars, banning the most polluting cars during CO2 emission peaks, closing roads and parking lots. One of the consequences is that today, Paris represents one of the fastest growing and most attractive markets for new mobility.

Beyond Europe

Globally, recent joint policy initiatives such as the Nationally Determined Contributions – Transport Initiative for Asia (NDC – TIA), which includes China, India and Vietnam, aim to promote a comprehensive approach on decarbonizing the transportation sector in Asian countries. The initiative seeks to do so by supporting the country partners in facilitating stakeholder dialogues and knowledge exchange and in developing strategies to effectively mitigate both greenhouse gas and air pollutant emissions in order to contribute to the enhancement of Nationally Determined Contributions (NDCs)[23]. Therefore, despite the current baseline of growing greenhouse gas emissions being released into the atmosphere, commitments to reduce emissions are prevalent at the local, national and global level.

1-4-4 An emancipation from fossil fuel dependency – the decarbonization of mobility

The transportation and mobility sector depends heavily on fossil fuels. In Europe, individual cars are still the main means of transportation for daily travel: in the UK, 61% of daily trips are made by car[24] and in France 76% of working people commute by car[25]. A green energy mix is therefore essential for sustainable mobility, with different alternatives to fossil fuel vehicles gaining market share and political support.

Greener individual vehicles

To reach a zero carbon emissions target, the main alternative to Internal Combustion Engine (ICE) cars for short journeys are electric vehicles (EVs) and hybrid electric vehicles (HEVs), powered with green electricity. The EV global market has grown by 60% between 2014 and 2018 and more than 400 EV models will be available by 2023[26]. To be net-zero emission vehicles, EVs must be fed with green electricity, which is why today an electric car in Germany emits 56% less CO2eq/km than an ICE car, whereas an electric car in France emits 77% less CO2eq/km than an ICE car[27]. EVs are still encountering challenges, as their profitability remains low because of the large investments needed for their development. Finally, the EV value chain lacks integration, which leads, for example, to battery-cell shortages. **The EV offer also needs to expand towards more affordable vehicles** (which depends mostly on the cost of the battery).

Fuel cell electric vehicles (FCEVs) are also solutions for zero carbon mobility. FCEVs are hydrogen fuel cells combined with a high pressure tank and a battery pack to produce electricity. However, the cylindrical shape

21. The European Commission, https://ec.europa.eu/info/sites/default/files/revision_of_the_directive_on_deployment_of_the_alternative_fuels_infrastructure_with_annex_0.pdf, 2021
22. The European Union Law, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3A4396542#:~:text=Compared%20to%202021%2C%20the%20regulation,new%20vans%20from%202030%20onwards, 2021
23. https://www.wri.org.cn/en/news/project-kick-ndc-transport-initiative-asia-%E2%80%93-china-key-decarbonize-transport-race-towards-net
24. 2019 National Travel Survey UK
25. INSEE
26. McKinsey – Expanding Electric Vehicle adoption
27. Transport & Environment

of the batteries and the lack of profitability for short journeys doesn't make FCEVs a good candidate for daily commuting.

Several solutions also exist to partially reduce CO2 emissions: improving the energy performance of combustion engines, reducing the size and weight of vehicles, or using biofuels or bio-methane. In 2019, bio-fuels represented 8,4% of energy consumption in transportation, and biodiesel represents the major part of biofuels consumption (80%). Biofuel solutions are already functional, but can put a lot of pressure on food-farming if they are used at a larger scale. That is why other biomass materials are being explored, such as algae or grass.

Greener public transportation

Public transportation also has green alternatives. If FCEVs may not be relevant for light vehicles, they represent a good solution for buses and trains, as well as electrical buses and trains. Hydrogen has a high energy density, so batteries can be lighter. Although it is a natural resource, the production process is highly polluting. On the other hand, electric bus fleets challenge the ability to create large charging stations, especially in urban areas, due to their great electric-demand peaks.

New mobilities

Another solution to achieve net zero emissions mobility while reducing the need for natural resources is to develop new mobility offers such as green ride-sharing and car sharing services with electric vehicles.

Even for very short trips, individual car usage remains too high. For example, personal car trips account for 76% of 2-3 mile trips in the UK[28], and for around 50% of 1-3 km trips in France[29]. In this case, "gentle" mobility and micro-mobility vehicles fueled with renewable energy (e-scooters, scooters, e-bikes, etc.) are the best alternatives to ICE cars for short distances.

1-5 Introducing the "SIMEC" Framework for Net Zero Emission Mobility

Our research shows that the most impactful drivers to decarbonize the mobility value chain can be gathered under a 'SIMEC' Net Zero Framework:

- **S**hared: fostering shared mobility solutions experience and accessibility instead of private ownership.
- **I**ntelligent: leveraging innovative technology to enable a convenient, fluid, and sustainable mobility.
- **M**ultimodal: putting in place the right incentives to drive the transition to an eco-responsible multimodal mobility.
- **E**co-Powered: accelerating uptake of zero-emission vehicles, renewable & low carbon fuels with related infrastructure.
- **C**ircular: reducing vehicles' carbon footprints along their lifecycle through a circular approach.

28. RACF Car report
29. INSEE

Figure 4 - Net Zero mobility "SIMEC" framework

	SHARED	INTELLIGENT	MULTIMODAL	ECO-POWERED	CIRCULAR
INDIVIDUALS	• Bicycle banks and other no-cost community-driven shared schemes • Peer-to-peer vehicle sharing marketplaces	• Carbon impact simulator • Carbon impact gamification • Eco-virtuous driving score	• Challenges to develop multimodal mobility	• ZE vehicle usage coach	• Campaign awareness for circular products • Incentive-based recycling schemes
COMPANIES	• Corporate vehicle sharing (BEVs, active modalities, etc.) Commuting and carpooling schemes	• Carbon impact gamification • Interactive workforce mapping • Flexible working frameworks/ technologies	• Corporate mobility & travel policies • Corporate mobility aggregators (MaaS, CMaaS)	• Corporate fleet electrification • Corporate charging points • Subsidies/economic incentives for BEV use	• Company-driven recycling programs
MOBILITY PROVIDERS & OPERATORS	• New vehicle sharing model • New ride sharing model • Shared active and micro-mobility services	• V2G, V2X • Telematics • Interoperability • Vehicle data sharing • Fleet management systems	• Mobility as a Service (MaaS)	• Electric/hybrid mobility • Hydrogen mobility • Synthetic liquid fuels • Next generation equipment (batteries, etc.)	• Modular design • Repair, Retrofit • Second life • Recycling/Remanufacturing
PUBLIC AUTHORITIES	• Urban space organization (smart curbs, smart metering, smart parking) • City-scale network & infrastructures	• Traffic management systems • City congestion prediction	• Mobility-as-a-Service (MaaS) • Zero emission mobility incentives / Tax schemes • First and last mile solutions	• Public fleet electrification • Public infrastructure (charging stations, etc.) • Incentives, legislation on ZE vehicle usage	• Recycling infrastructures and plans • Remanufacturing/durability/ efficiency/maintenance standards

2 THE ECOSYSTEM IN MOTION: TRANSITIONING TO NET ZERO PER ACTOR

2-1 Users: accelerating eco-responsible behavior

The mobility of people accounts for 2/3 of mobility GHG emissions on average[30], with 90% of emissions coming from road transportation (cars, trucks, etc.) There is an urgent need to implement initiatives with the following principles:

- All types of eco-friendly nudges will incentivize people to change their mobility behavior
- Incentivizing people in changing their mobility behavior must be considered in terms of scale and network
- A convenient and seamless mobility user experience is fundamental to accelerate multimodal habits

The most impactful initiatives launched over the past few months fall into 3 sections, under our "**Intelligent**" pillar:

- **Carbon Impact simulator**, to make passengers aware of the carbon impact of each trip and encourage low carbon emissions. In France, Dataagir provides an estimation of carbon impact
- **Carbon Impact reward**, to ensure that eco-friendly trips are attractive. This is the category where we recorded the greatest number of initiatives launched. These multimodal or unimodal initiatives are launched by government or private companies to encourage the use of their mobility alternatives:
  - **Multimodal**: the Finnish government launched Citycap app, in which citizens get rewards such as discounted bus tickets or bicycle repair services, in exchange for smart mobility choices and low personal carbon footprints. Italy and Spain have launched similar projects.
  - **Monomodal**: The Tripzoom app tracks riders from Sweden, the Netherlands and the UK on their bike rides and rewards them based on their performance. Ridesharing French platform Casten offers rewards to drivers for each ride.
- **Driver Score**, to enhance "eco-virtuous" driving. From our study[31] **83% of customers expect OEMs to better leverage digital technologies to support sustainable driving**, such as navigation-based drive control for plug-in hybrids. As a concrete example, Fiat launched in 2021 the first automotive scheme to reward "eco-virtuous" driving styles, together with the start-up KIRI Technologies. The more sustainable a drivers' driving style is, the more Kiri coins (eco-friendly digital currency) the driver earns.

Accelerating eco-responsible behaviour

For the Ministry of Ecological Transition, Capgemini and La Fabrique des Mobilités are proud to be key players in the launch of a unique digital platform called "Mon Compte Mobilité" in 2022. This platform will give citizens **access to all existing financial incentives** granted by public authorities and employers. Citizens will be able to subscribe to those incentive and follow up on their consumption, while public authorities and employers will gain insight on the impact of their mobility policies. As a **trusted intermediary**, connecting the different mobility actors (citizens, companies, communities and mobility service providers), it will set up a **virtuous sustainable mobility circle**.

2-2 Mobility Providers and Operators: fostering green innovation and services

The growth of new technologies such as connected cars and smartphones has enabled mobility providers and operators to supply more innovative and sustainable services in recent years. Mobility providers and operators work in three main domains: Mobility as a Service (MaaS), mobility systems and shared mobility services. **The MaaS ecosystem includes transportation infrastructure, services, information and payment services**. The second domain, the mobility system, covers technologies (batteries, EVs), infrastructure (charging stations, electricity grid), and users (manufacturers, suppliers, end users, governments etc). The third domain, shared mobility services, includes the peer-to-peer approach (such as bike sharing, ride sharing, carpooling) and mass transit systems (public transportation, airport shuttles, etc.)[32]. Going beyond these domains, the future for mobility providers and operators lies in providing urban green mobility solutions and services that include (i) low carbon, high energy efficient road vehicles, e-vehicles and (ii) automated transportation.

30. SLOCAT, Tracking Trends in a Time of Change: The Need for Radical Action Towards Sustainable Transport Decarbonization, tTransport and Climate Change Global Status Report – 2nd edition, 2021
31. Capgemini, Sustainable Mobility, What do customers and car buyers experience today, and how can OEMs turn sustainability into a competitive advantage?, March 2021
32. World Electric Vehicle Journal, 2019.

Feedback from our survey on low carbon initiatives

According to the feedback from our survey identifying low carbon flagship initiatives in the mobility sector, over 75% of the respondents had initiatives in place. The main objectives for implementing these initiatives to reduce carbon emissions are to meet regulatory requirements as the first priority and to respond to customer and employee expectations is cited as a second and third priority (see figure 1 below). The majority of the initiatives are shared mobility oriented (30% of the responses), followed by renewable and low carbon energies and smart mobility (both around 24%), then multi-modal transportation (at 13%), with the least popular being the optimization of the product life cycle (11%) (see figure 2 below). The survey indicated that for MSPs, the initiatives were shared mobility and smart mobility and for OEMs, it was renewable and low carbon energies and the optimization of the product life cycle. Furthermore, it also indicated that the types of projects that could be implemented were shared mobility, monitoring MaaS and interoperability solutions. The survey revealed that the main difficulties to implementing these initiatives include a lack of cooperation within the ecosystem and low budgets.

Figure 6 - Mapping of Net Zero initiatives

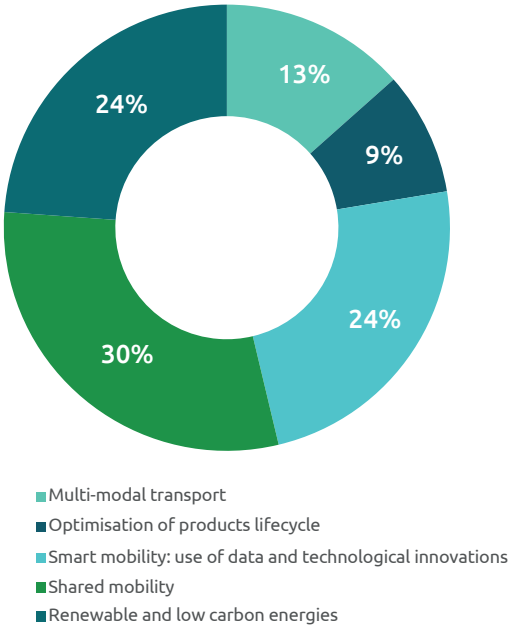
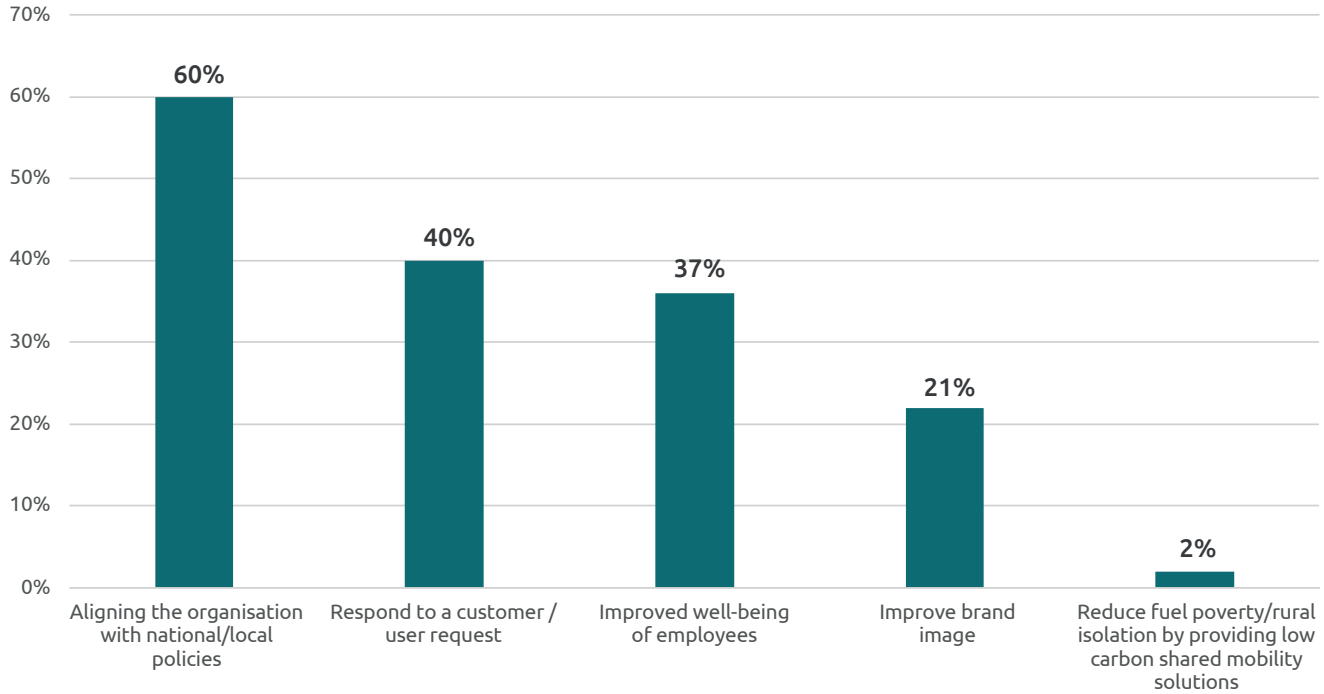


Figure 5 - Main objectives of organisations in reducing carbon emissions



32. World Electric Vehicle Journal, 2019
33. Capgemini and Autonomy Survey, Net Zero Mobility Emission Survey, 46 answers, 2021

The main drivers for mobility providers and operators to foster innovative green mobility solutions and services, along with examples of flagship initiatives include:

1 - Intelligent. Sustainable mobility can only emerge through increased digitization and data sharing within the urban mobility ecosystem. Data sharing could enable multiple transportation solutions, including multimodal and integrated mobility services, optimized planning and operation of electric vehicle charging infrastructure, optimized fleet management that relies on advanced data collection and use capabilities, among others[34]. **While there is increasing interest and growth in the mobility data sharing space, it is yet to become widespread globally**, especially since challenges of data security and coordination of data sharing between the public and private sectors can be difficult.

– **Data sharing platform on electric mobility**: Within the French ecosystem, AVERE.Unite, the national association for the development of electric mobility, has a platform that acts as a central portal of information, content and educational initiatives on the electric mobility ecosystem, directed towards mass consumers including private, public and institutional consumers. The platform has further promoted the purchasing of electric vehicles, as a result of clear and coherent messages that are focused on the different types of electric vehicles, chargers and prevalent financing benefits[35].

2 - Circular economy strategies and services. Circular economy oriented strategies and services have the potential to reduce the carbon footprint of urban mobility products and directly address net zero emissions. A circular mobility system would be accessible, affordable and energy efficient, built upon a multi-modal mobility structure that integrates public transportation with other flexible alternatives. Beyond these factors, circular design models would be integrated into vehicles and infrastructure. The design of these assets is key to the circular economy transition, as the principle aim is to eliminate or drastically reduce waste and pollution from the system and extend the life, use and value of mobility systems. This can happen through the ability to remanufacture the materials used and through facilitating shared use[36, 37]. While the integration of circular economy strategies in mobility is in the nascent stages of its growth, this space is expected to continue to grow in the years to come.

– **Conversion of car production lines into a circular economy factory**: According to recent Capgemini research, the increasing importance of sustainability is particularly underlined in the automotive industry, with 62% of automotive organizations claiming to have developed a comprehensive sustainability strategy with well-defined goals and targets[38]. Groupe Renault is an example of an organization that has created a comprehensive sustainability strategy linked to the development of circular economy products and services. The organization is in the midst of a 3-year project, aiming for completion in 2024, to convert car production lines into a circular economy factory. Involving a large network of partners across sectors, including local authorities, startups and academic partners, the factory will be structured around four activity centres, including (i) **retrofitting** i.e. the conversion of thermal vehicles to be less dependent on fossil fuels, (ii) **re-energy**, which involves developing the potential of applications that arise from electric batteries and energies such as hydrogen, (iii) **recycling**, which involves an efficient management of resources including developing a growing share of recycled or reused materials, and (iv) **re-start**, which will be focused on developing industrial know-how and accelerating research and innovation in the circular economy. The four activity centres will operate in an interconnected and complementary manner[39]. During talks with experts in the industry, we found that within the industry, there is also a will to keep the vehicle asset under control by the manufacturers for as long as possible. This would include the vehicle asset being made available with successive reconditioning and resale to suitable customers at the appropriate price, so that the circular economy model, while being sustainable can also generate additional economic value.

Capgemini's support to the company Circle

Since 2020, Capgemini has supported our company, Circle, to create an innovative experience around a new 100% electric, 100% digital urban vehicle concept dedicated to the free-floating market. From vision to execution, the business, design and technological expertise of Capgemini helped us to define our vision, customer experience and target architecture in preparation of the market launch.

Eric Boullier, CEO, Circle

34. World Business Council for Sustainable Development, Sustainable Mobility: Policy making for data sharing, 2021.
35. AVERE.Unite.
36. Circular city funding guide, What are the benefits of a circular mobility ecosystem?.
37. Ellen MacArthur Foundation, Cities in the circular economy: An initial exploration, 2017.
38. The automotive industry in the Era of Sustainability, Capgemini Research Institute, 2020
39. Automotive World, Groupe Renault creates the first European factory dedicated to the circular economy of mobility, 2020.

3 - Eco-powered technology. Eco-powered technology includes accelerating the use of zero emission vehicles, particularly in the cases of fleets, as well as increasing the availability of renewable and low carbon fuels, along with providing the necessary infrastructure, such as charging stations and services. Within the EU, there are select priority areas for action within the low emission mobility strategy. These include speeding up the deployment of low emission alternative energy for transportation, such as the use of advanced biofuels, electricity, hydrogen and renewable synthetic fuels, as well as removing obstacles to the electrification of transportation[40]. Despite progress being slow, **companies are increasingly committing to switching away from the internal combustion engine to electric vehicles, especially in the automotive sector**. For instance, 16 OEMS with 65% market share have announced exit dates for the internal combustion engine. Select examples include Volkswagen's plan to manufacture all electric cars by 2040 and BAIC Motor looking to phase out conventional fuel cars by 2025, amongst others[41].

2-3 Corporations: creating change from the inside-out

With local mobility accounting for 70% of transportation-related emissions, and business-related trips making up the majority of distance traveled, companies play a significant role in accelerating the adoption of low-carbon alternatives through their employees' mobility habits and patterns. Despite the significant disruptions that the COVID-19 pandemic brought to commuting and business travel, the employee-mobility market is projected to reach a value of US$791.9 billion by 2026[42].

In parallel to the wider mobility industry's often-discussed need to shift away from private ICE vehicle usage and towards new mobility alternatives, similar developments and expectations are beginning to take hold in the corporate and business travel market. With mega trends like shared mobility, electrification, and multimodality, corporations have never been better positioned to alter their employee mobility offerings in pursuit of more low-carbon alternatives. Corporations have seen reduced demand from employees to follow the traditional company car ownership model, alongside a significant push in the expectation to adopt more sustainable practices.

Particularly given the challenge of slow consumer adoption of sustainable mobility practices, large employers have the potential to significantly reduce the environmental impact of their employees' travel patterns. With the power to change practices quickly and at-scale by implementing company-wide solutions, influence peers and other players in their respective sectors, and apply various tools and resources to find solutions to common challenges, **corporations must be considered as key players in the transition to net zero mobility**.

With the onset of shared economy business models and principles in the world of corporate mobility, these trends also offer companies the chance to make good on their CSR policies – of which emissions reductions strategies must be integral. Numerous studies have shown that businesses with a commitment to CSR have higher rates of job satisfaction and talent retention. According to a study from Stanford University Graduate School of Business[43], 90% of the MBA graduates surveyed said that **reputation-related attributes like environmental sustainability, community/stakeholder relations, and ethical products and services were highly important in job choice decisions**.

As previously mentioned, the main drivers establishing corporate mobility as a key lever in net zero emissions strategies are **electrification, shared mobility solutions, and multimodality**. Conducting an analysis on the most impactful initiatives happening in the corporate mobility sector, we identified the following as stand-out examples:

- **Eco-powered (Electrification)**: In accordance with its participation in EV100, Bank of America launched a Low Carbon Vehicle Program to provide assistance to employees for the adoption of electric vehicles. Under the program, employees receive a $4,000 reimbursement for the purchase or $2,000 for the lease of a new, eligible, highway-capable electric or hydrogen fuel cell vehicle. To-date, over 10,000 employees have benefitted from the scheme. As a part of the program, Bank of America has also increased its installation of EV workplace charging ports, giving almost 50,000 employees better access to EV charging stations at work.
- **Multimodal**: ENEL Brazil, a multinational energy company and Brazil's top solar and wind player. Facing challenges such as an idle corporate fleet, inefficient commuting patterns and high prices for employees, ENEL developed a corporate mobility management app that integrated with other regional services. Users input their origin and destination, and the app determines the most efficient and economical route. When other users identify a similar route, the app suggests pooled rides whenever possible. Today, 18% of the company's trips are shared and it has seen a 35% drop in idleness.

2-4 Governments and local public authorities: orchestrating sustainable mobility policies

To accelerate the progress towards net zero, governments and local public authorities must embrace a systemic approach. Over the past 2 years, an increasing number of public players have taken bold moves, the very first being to allocate a dedicated part of the budget to finance climate change and sustainable

42. ReportLinker 2021, Global Business Travel Industry.
43. Stanford University 2003, Corporate Social Responsibility Reputation Effects on MBA Job Choice
40. European Commission, A European strategy for low emission mobility, 2016.
41. WEF, McKinsey, Zero Emission Area Handbook, 2021.

mobility projects impacting both cities and local public authorities (and not just at the city level). In August 2021, Quebec city signed a $100M plan to reduce their GHG emissions by 40% by 2030 through 20 projects, impacting the entire local authority[44].

Data from The Energy Policy Tracker

The Energy Policy Tracker database shows that only 44 percent of $298 billion global recovery funds dedicated to the transportation sector between March 2020 and February 2021 have a positive impact on climate and sustainability[45].

150+ cities have planned or initiated ideas to reduce mobility-related emissions[46].

From our research, we strongly believe that shared, multimodal, eco-powered and intelligent initiatives are the main drivers of change for local public authorities, as they can raise awareness, stimulate investment, and influence long-term change:

Shared & Multimodal: The most impactful initiatives for public authorities are to:

- **Develop the use of Mobility-as-a-Service** (Maas) platforms: Capgemini research shows that more than 40 European cities have launched a MaaS platform and that public authorities are probably the best-situated actors to orchestrate and expand MaaS solutions[47].
- **Incentivize users through an attractive and seamless mobility journey offering** (e.g. French incentives to repair old cycles) or incite change through taxation or other financial mechanisms (e.g. Stockholm imposing city-center tolls from 6:30 a.m. to 6:30 p.m.)
- **Organize urban space** to accelerate the development of free-floating zones or Zero Emission Zones (ZEZs) within cities, where only low-emission mobility modalities are allowed. As an example, France just enacted the development of ZEZs in 11 cities, including 7 new ones in 2021.
- **Develop shared "First Mile" and "Last Mile"** solutions in areas where car usage is unavoidable.

Eco-powered: The most impactful initiatives for Public Authorities are to:

- **Set binding laws** to accelerate the shift to eco-powered mobility products, with exit dates for internal combustion engines, as embodied by the recent EU announcement.
- **Accelerate the transition of public transportation towards eco-powered solutions**: Amsterdam and 13 other Dutch cities will switch to purely electric public transportation by 2030, while London committed to buying only zero-emission buses from 2025[48]. Whatever the means of transportation, we believe that public transportation is the cornerstone of the net zero transition: choosing public transportation does not only reduce carbon emissions, it also reduces other systemic issues such as traffic congestion (1 bus takes up roughly the equivalent space of 40 cars).
- **Invest in the future to transform carbon-based means of transportation**: France invested $1.8 billion in R&D to support the launch of a clean fuel airplane by 2035[49].
- **Develop appropriate infrastructure** (hubs, charging infrastructures, battery collection network, recycling facilities). Coordinating charging station master plans on the national and local levels will also have a positive impact on the economy: the International Energy Agency (IEA) estimated the creation of 12 jobs on average per $1 million invested in public charging stations[50].
- **Develop charging terminal certification** to qualify the variety of charging terminals available in the market, thereby improving the consistency of the quality of service offered.

Intelligent:

- Local Public authorities can benefit from Intelligent Technologies and accelerate the net zero transition by solutioning city congestion. On average, drivers spend 5 entire work weeks a year stuck in traffic[51]. Urban mobility flow video analysis with AI such as Wintics can reduce city congestion.

The Arval Mobility App

At Arval, we have built a unique mobility hub concept, the Arval Mobility App, where employees can access a large range of on-demand transportation services. This Mobility-as-a-Service application, which aggregates both Arval and external mobility solutions, enables employers to set-up their mobility policies, measure their impacts and adjust them with personalized recommendations to achieve companies' objectives.

Ronan Perrier, Head of Mobility for Corporates, Arval

44. https://ici.radio-canada.ca/nouvelle/1805114/ville-quebec-plan-reduction-ges-regis-labeaume-onu?&utm_source=newsletter&utm_medium=email&utm_campaign=pandemie_frein_ou_catalyseur_de_changement_pour_la_mobilite&utm_term=2021-08-26
45. https://www.energypolicytracker.org/ quoted on Greenbiz, 5 opportunities for transport to play a starring role in countries' climate ambitions, July 2021
46. Zero Emission Area Handbook, World Economic Forum and McKinsey, May 2021
47. The future of Mobility-as-a-Service Platform, Capgemini and Autonomy, November 2020
48. Zero Emission Area Handbook, World Economic Forum and McKinsey, May 2021
49. Greenbiz, 5 opportunities for transport to play a starring role in countries' climate ambitions, July 2021
50. International Energy Agency, Energy efficiency jobs and the recovery, 2020
51. Enabling Data Sharing, Emerging principles for transforming urban mobility, WCSBD, January 2020

3 CONCLUSION AND THE WAY FORWARD

In the race to achieve net zero emissions by mid-century, there is no question that the mobility sector plays a crucial role. However, mobility remains one of the slowest sectors to decarbonize and still accounts for some of the largest shares of emissions at the global level. For those sectoral players who took part in this paper's survey, a lack of ecosystem cooperation and budgetary constraints represent the greatest obstacles preventing the implementation of more green projects within their organisations. Mobility, just like other industries, cannot continue to rely upon the promise of carbon offsetting to get by.

Decarbonization in the mobility sector can only be achieved if there is a strong focus on value chain emissions. In order to accelerate the move towards sustainable mobility and achieve a net zero transition, a major shift in investment and business models is required, as well as a legal framework for sustainable mobility that is supported by a conducive policy environment.

In order to reach net zero, we strongly believe that each actor in the ecosystem needs to make a transition :

- **(i) Consumers** need to be incentivized in changing their mobility behavior
- **(ii) Mobility providers and operators** are responsible for fostering green innovation and services
- **(iii) Corporations** can play a significant role in accelerating the adoption of low carbon alternatives through their employees' mobility habits and patterns
- **(iv) Governments and local public authorities** must take a systemic approach to accelerate the progress towards net zero emissions, for instance by allocating a dedicated part of the budget to finance climate change and sustainable mobility projects.

Capgemini Smart & Sustainable Mobility Offering

Capgemini is proud to be a trusted partner for traditional and new mobility players to design, deliver and launch smart and sustainable projects. We have built an end-to-end approach to support our clients on their road towards sustainable and net zero mobility. This approach relies on 4 pillars, leveraging the skills of our business strategists, designers, and data/tech engineers:

- **Sustainable Mobility Path**, where we set the net zero "North Star," from the baseline to the ambition; we bring our sustainable mobility expertise to define relevant roadmap and initiatives and to measure carbon reduction measures
- **End-to-End Sustainable Mobility Business**, where we help our clients imagine disruptive – yet viable – business models. To bring them to life, we adopt an end-to-end approach combining "Net Zero By Design'' and green delivery: we craft compelling green experiences throughout user journeys, we define new products and services (e.g. retrofit impact, longer vehicle life cycles etc) and implement green delivery principles for operating models.
- **Sustainable Mobility Orchestration**, where we imagine new positioning, partnership approaches and relationship models for our clients in this new Mobility Value Chain.
- **Sustainable Mobility of employees**, where we design and deliver new engaging mobility experiences for your employees in order to achieve sustainable commuting.

Sustainable Mobility Path	E2E Sustainable Mobility Model	Sustainable Mobility Orchestrator	Sustainable mobility of employees
Transition risks and opportunities analysis Identify the risks related to the transition, estimate them and prioritize the actions	**New Business Model** Pivot business models to align low carbon economy stakes and ROI objectives	**Green & digital Value chain** Map stakeholders around the value chain (raw material, analyse the use of the good/service by the consumer, recycling, disposal)	**Sustainable commuting** Evaluate the GHG emissions from scope 3, determine the part coming from the mobility of employees. Determine best practices
SBT trajectory and commitment Consolidate the current carbon footprint, design a reduction pathway and set SBTi approved targets	**Green Mobility Experience** Fullfill users' green expectation through the whole user journey with new products/services design (e.g. retrofit models) & experience	**Sustainable collaboration** Identify the actors with whom cooperation will be most efficient to reduce GHGs	**New mobility experiences** Design, launch and measure new employee mobility initiatives (bicycle fleets, electrification of the fleet)
Decarbonization levers Assess emissions according to the 3 scopes, identify decarbonization levers and define milestones	**End to End Green Delivery** Launch new products & operating model including « Net Zero by design » (e.g. Green IT)	**Responsibility in a sustainable Value chain** Define responsibility & value sharing across the ecosystem to enable re-use of services / Products	**Engage on initiatives** Define engagement strategy and carry out communication policies around these new practices
Climate Roadmap Design Roadmap by BU or by site			

Collaboration between Capgemini Invent and Autonomy

Capgemini Invent and Autonomy have combined their expertise to design this net zero emission vision for the future of mobility. Capgemini Invent brings to this point of view experience in supporting the design and implementation of net zero emissions initiatives to all the actors of the ecosystem. Thanks to its large network of partners, Autonomy provides a detailed analysis of the players, challenges and dynamics in the mobility market. During the first half of 2021, a survey on 50 companies and the preparation of a joint event at Autonomy on this topic with experts from Keolis, Arval, Renault and Nouvelle Aquitaine helped to understand the opportunities, the dynamics of development and difficulties faced.

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As the digital innovation, design and transformation brand of the Capgemini Group, Capgemini Invent enables CxOs to envision and shape the future of their businesses. Located in more than 36 offices and 37 creative studios around the world, it comprises a 10,000+ strong team of strategists, data scientists, product and experience designers, brand experts and technologists who develop new digital services, products, experiences and business models for sustainable growth.

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About Autonomy

Autonomy is an international trade show and mobility network for sustainable urban mobility solutions. Based in Paris, the company produces industry leading content through its newsletters, the Urban Mobility Weekly and the Business of Bicycles, as well as through its Knowledge Platform, white papers, reports and webinars. Autonomy offers bespoke solutions for cities, public sector agencies and private sector companies looking to communicate to its wider mobility community

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