

MAKING THE SHIFT —

An aerial photograph of a two-lane asphalt road winding through a dense, lush green forest. The road has white dashed lines and a white arrow pointing to the right. A large, semi-circular teal overlay covers the left side of the image, framing the text. The text is centered within this teal area.

**CHANGING GEAR
IN THE JOURNEY
TOWARD
SUSTAINABLE
MOBILITY**

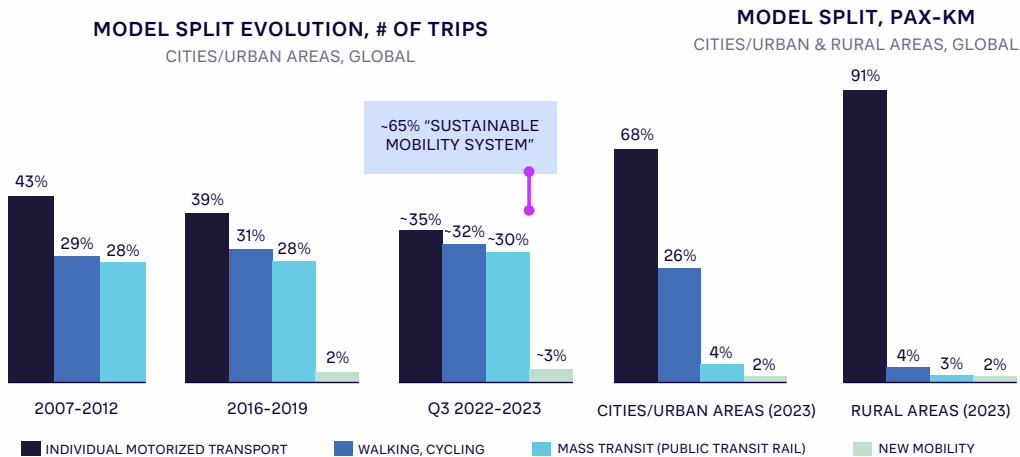
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When Arthur D. Little (ADL) first set up its Future of Mobility Lab in 2010, there was much optimism that by now, we would have made significant progress toward the goal of more sustainable, resilient, safe, inclusive, efficient, and human-centric mobility systems in our cities. Technological developments — particularly the rapid advances of digitalization, connectivity, and automation — promised the ability to deliver tailored, diverse, and convenient mobility solutions to customers that would be attractive enough to prompt a major shift away from private cars.

Fourteen years on, things haven't quite happened the way many expected, though there has been progress in some areas. In today's city centers, for example, we have seen growth in public transport and active mobility (walking and cycling), as well as the introduction of "new mobility" solutions, such as shared and owned micromobility devices (e-bikes and e-scooters) and car sharing, ride hailing, and electric-powered personal mobility devices.

However, the bigger picture is less rosy. If we consider that mass transit, walking/cycling, and shared mobility modes were collectively sustainable over the 15 years leading up to 2023, the share of these modes has only grown from some **57%** to around **65%** globally, while the remaining **35%** of trips are still made by private car. And if we look at pax-km instead of trips, we see that private cars still represent about **70%** in urban areas and **90%** in rural areas (see Figure 1).



Note: (1) New mobility includes shared and micromobility (car sharing, bike sharing, e-scooter sharing, etc.); individual motorized transport includes taxi and ride-hailing; private mobility devices are not accounted for
 Source: Arthur D. Little

FIGURE 1: EVOLUTION OF MODAL SPLIT (# OF TRIPS) AND % PAX-KM

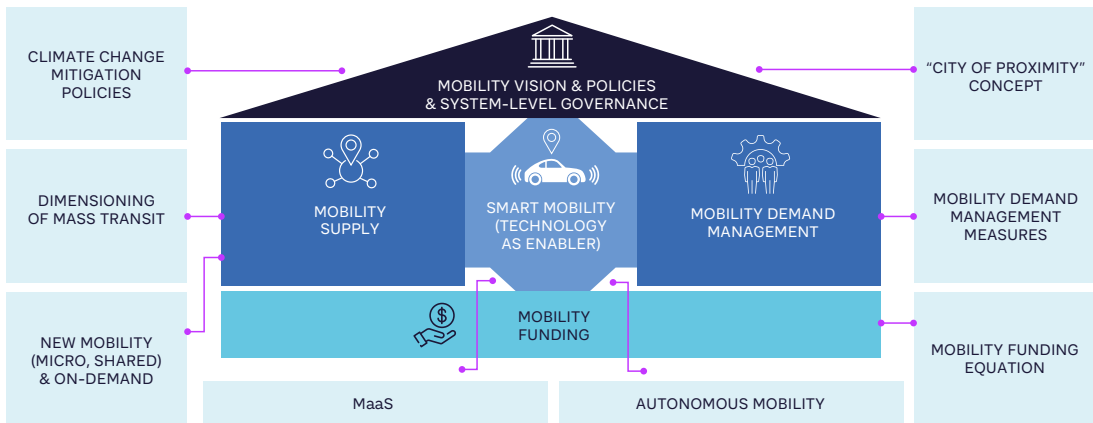
ADL’s Q4 2023 “Future of Mobility” survey of more than 16,200 respondents globally¹ confirms the trend: more than **70%** of citizens use private cars for their daily commute. However, on a more optimistic note, the survey also shows that **42%** of citizens would consider forgoing at least one of their cars if sufficient mobility alternatives were made available to them.

This lack of progress has implications for transport externalities. For example, transport still accounts for 25-40% of national CO2 emissions in Europe, the only sector with a steady increase since 1990. Transport still leads to many casualties, and, despite less congestion post-COVID-19 due to increased working from home, levels have been growing again since 2023, and the average commuting time to work has not improved.

At best, we can talk of an evolution toward more sustainable mobility but certainly not a revolution. Why is this the case, and what should stakeholders such as transport authorities, mobility operators, and investors do to shift gear and accelerate? Drawing on a recent major joint ADL/POLIS² study, this article offers a quick overview of the challenges and solutions to sustainable mobility. The full study, “The Future of Mobility 5.0,”³ addresses the various issues and solutions in depth.

As part of the study, we undertook eight deep dives into key challenges and promising solutions to overcome them. We mapped these against the framework ADL uses to describe the key building blocks of a virtuous mobility system⁴ (see Figure 2).

1. “Future of Mobility Worldwide Survey (Q4 2023).” Arthur D. Little, September 2024.
 2. POLIS is a network of European local and regional authorities cooperating on innovative and sustainable urban mobility.
 3. “The Future of Mobility 5.0.” Arthur D. Little/POLIS, September 2024.
 4. This framework was first introduced in the 2014 ADL/UIPT (International Association of Public Transport) study, “The Future of Urban Mobility 2.0: Imperatives to Shape Extended Mobility Ecosystems of Tomorrow.”



Source: Arthur D. Little

FIGURE 2: EIGHT SOLUTIONS REVIEWED AS PART OF "THE FUTURE OF MOBILITY 5.0" STUDY

Our analysis led us to conclude that, with comprehensive implementation, appropriate funding, and robust governance at the system level, the following **high-impact solutions could potentially double the global share of sustainable mobility from approximately 30-60% of pax-km** within the next decade.

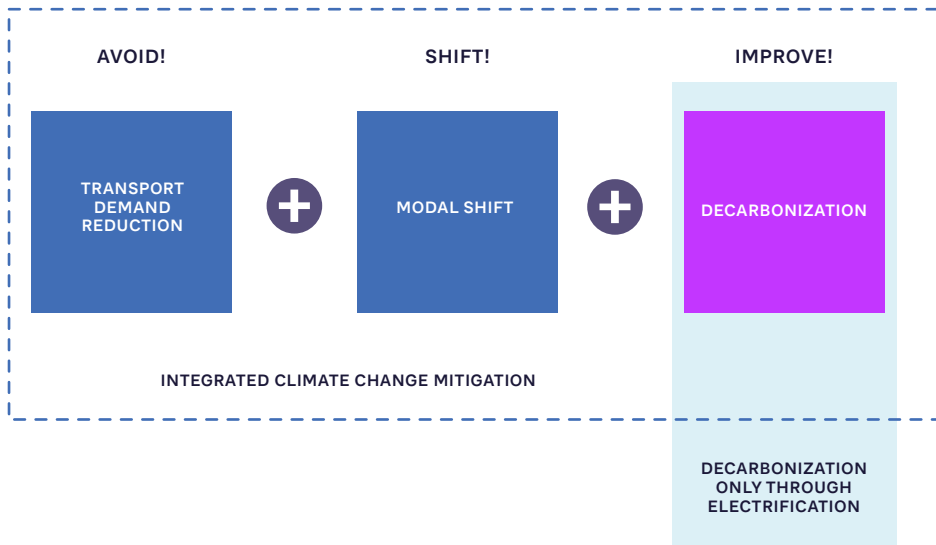
MOBILITY VISION AND POLICY

CLIMATE CHANGE MITIGATION

Recent years have seen significant progress in the development of long-term mobility visions and policies and their integration within wider urban strategies. This trend is especially pronounced in Europe, driven by the implementation of sustainable urban mobility plans (SUMP). These plans strive to establish holistic urban mobility policies that enhance quality of life and are developed through a collaborative process involving a broad spectrum of stakeholders from both public and private sectors.

This certainly moves us in the right direction, but there are still difficulties in adopting adequately integrated policies to secure progress on climate mitigation, and the move toward net zero is still challenging. For example, many policies center on electrification. However, the electrification of private cars is not enough on its own, and in any case, its contribution is slow because of cars' long replacement cycles.

Mitigating climate change's impact requires a more joined-up policy approach, whereby electrification is complemented with other key levers, particularly modal shift and transport-demand reduction, to maximize overall impacts (see Figure 3).



Source: Arthur D. Little

FIGURE 3: KEY LEVERS FOR ACHIEVING NET ZERO IN TRANSPORT

As shown in Figure 3, an effective transport emission strategy needs to focus on three levers:

1. **Transport demand reduction:** Historically, the surge in car usage has been a primary contributor to increased emissions. However, the COVID-19 period demonstrated that significant changes are achievable with sufficient determination. Reducing demand can be accomplished by eliminating unnecessary trips, shortening travel distances, and employing behavioral change strategies. Restricting measures for solo car driving can also be considered where other competitive options are available to enhance vehicle occupancy rate.
2. **Modal shift:** This is about promoting a shift to less energy-intensive mobility modes, away from private cars toward mass public transport, active mobility, and new mobility modes such as micro, shared, and on-demand mobility. As is clear from individual car usage trends, making progress has been difficult and is partly driven by a lack of political will.
3. **Decarbonization through electrification:** This approach aims to achieve very low CO₂ emissions thanks to electricity from low-carbon sources (kg CO₂/kWh), as well as better energy efficiency per km traveled (kWh/km). This can be only partially achieved over the short term with better internal combustion engine (ICE) fuel efficiency and use of alternative fuels including biofuels, as long as the potential negative impacts of crop-based biofuels (land use and food price increases, among others) are minimized.

France offers a good illustration of the need for an integrated strategy. Between 1990 and 2018, energy efficiency and carbon intensity improved by 40% and 10%, respectively, mainly through electrification. However, a 24% modal shift to private vehicle usage and a 30% decrease in vehicle occupancy rate meant that, overall, CO2 emissions climbed almost in step with transport demand.

“CITY OF PROXIMITY” CONCEPTS

First, we shape the cities — then they shape us. Reshaping mobility behaviors also requires reshaping public spaces away from a century of car-centric transport policies. Implementation of the “city of proximity” urban spatial-planning concept, the most famous of which is the “15-minute city” introduced by Carlos Moreno in 2016, aims to enable more sustainable, livable, and healthier cities by considering the closeness of services needed by citizens. Many examples of partial implementation of such concepts can be seen worldwide in cities such as Paris, France; Portland, Oregon; Melbourne, Australia; Glasgow, Scotland; and Copenhagen, Denmark, with good local results in improved congestion, pollution, and quality of life.

Overall, the concept of the city of proximity has great potential to contribute to sustainable mobility. In the future, city authorities should pursue efforts to deploy the concept at a larger scale, with possible adaptations to cater to how digitalization has changed citizens’ needs for proximity and with a stronger emphasis on measuring systemic impacts.

MOBILITY SUPPLY

DIMENSIONING AND MATURITY OF PUBLIC TRANSPORT

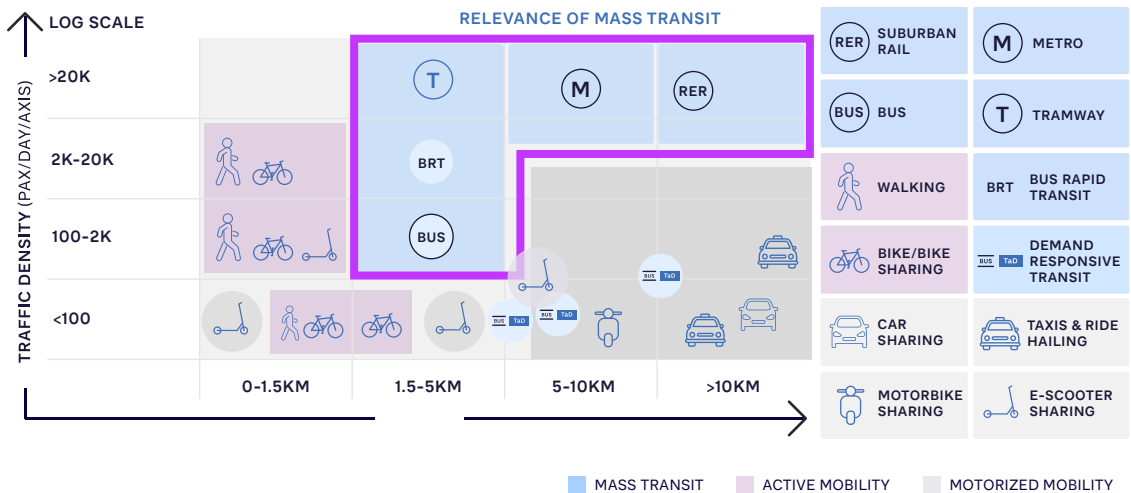
Improving mobility supply is about ensuring that the right mix of mobility services, modes, and infrastructures is available to meet evolving user needs, achieve sustainable mobility policy objectives,

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and ensure that flows of people and asset utilization are optimized within and around cities and regions.

Authorities should become smarter with transport mode allocation by developing multimodal masterplans

and prioritizing transport services according to their performance and affordability. That means further development of mass transit as the “backbone” of the virtuous mobility system whenever traffic density justifies the investments. It also means encouraging the use of active and micromobility services for under 5 km trips and shared and on-demand motorized mobility, such as car sharing, taxi, and ride hailing, for longer-distance travel and in lower-density areas where investment in mass transit is not justified (see Figure 4).



Source: Arthur D. Little

FIGURE 4: OPTIMAL ALLOCATION OF TRANSPORT MODES

NEW MOBILITY (MICRO, SHARED, AND ON DEMAND)

Micromobility services, especially e-scooters, e-bikes, and e-Scooters (either shared or owned), are services with relatively high demand/willingness to pay and are often used together with public transport to cater to door-to door intermodal trips use-cases. There also seems to be demand for car-sharing and ride-hailing mobility services to support multimodal life use cases, which involve using different modes for different journeys and needs, both within and outside of cities. Mass-transit operators and shared new mobility services providers thus have a shared interest in bringing about the shift away from private cars. Authorities must cultivate new mobility as part of the mobility menu and foster partnerships with new mobility service providers rather than merely seeking to regulate them. That also means new mobility service providers must be more interested in “ecosystem plays” to maximize success and improve their economic viability.⁵

SMART MOBILITY (“TECHNOLOGY AS ENABLER”)

Technological innovation is essential and can serve as a powerful catalyst to deliver on the promise of a more virtuous mobility system. However, it can also be a double-edged sword and must be carefully guided to ensure it addresses genuine needs instead of promoting solutions in search of a problem.

5. Van Audenhove, Francois-Joseph, et al. “Sharing in Success: How Car Sharing Can Deliver on Its Potential in an Ecosystem Play.” Arthur D. Little/movmi/The Mobility Cooperative, 2024.

MOBILITY AS A SERVICE

The mobility as a service (MaaS) concept, which allows consumers to plan, book, pay for, and access various mobility services through a single digital platform, has been a prominent innovation in mobility over the last decade. It promised to facilitate a shift from ownership to usage of mobility devices and reduce reliance on private cars. However, despite some progress, the overall expansion of MaaS has been sluggish and largely failed to fulfill these promises. A primary reason is that most MaaS implementations have adopted a one-size-fits-all, technology-centric approach without adequately addressing the specific needs of users, service providers, or authorities. In terms of the Gartner hype curve, with less than 5% of the potential audience adopting it, we are probably close to the “Trough of Disillusionment.”

MaaS is certainly part of the solution to achieving a more “virtuous mobility system,” but it needs to evolve beyond merely serving as an “umbrella app” for existing services. It should offer added value, such as enhanced system-level functionalities that benefit both customers and cities, cater to specific target groups such as tourists and private car owners, and support broader mobility goals (for instance, by suggesting routes that favor sustainable modes). Furthermore, improved collaboration within an open data ecosystem is essential for the effective realization of MaaS.

AUTONOMOUS MOBILITY

Automation of mobility services will be part of our cities and regions in the not-so-distant future, and its deployment could help solve some of today’s pressing issues, such as lack of drivers, safety, and how to service remote areas. However, autonomous L4⁶ technology is progressing more slowly than predicted and has not yet achieved

the breakthrough needed for general application in mixed traffic, even if it is now expected sooner rather than later. We expect the benefits of autonomous not to be realized through individual automated vehicles but through connected

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vehicles in smart traffic systems. Vehicle manufacturers need to prepare technology for integrated mobility systems rather than just individual vehicle solutions. The right use cases and applications must be selected for the post positive impact at overall system level (rather than talking about technology readiness). Today, low-hanging fruit can be found in traffic, such as automated bus rapid transit systems on dedicated lanes or remote-controlled vehicles, as well as within premises, such as automated bus driving in depots.

6. L4 refers to autonomous vehicles that are fully self-operational within set boundaries and require no attention or assistance from a human driver.

MOBILITY DEMAND

MOBILITY DEMAND AND ACCESS MANAGEMENT MEASURES

Prioritizing a shift toward sustainable mobility behaviors is crucial for enhancing transportation systems. Our latest “Future of Mobility” survey⁷ study shows that the availability of alternative mobility services influences only about 30% of potential readiness to abandon personal cars. The other 70% needs to be addressed through effective demand management strategies.

Mobility demand and access management strategies can be diverse and must be supported by thorough cost-benefit analyses that include externalities and are carefully tailored to each unique context. Our study examined 40 potential measures and found that while some high-impact options — such as urban planning,

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land-use models, and dynamic tools such as congestion charging — can be challenging and expensive to implement, other effective measures are more feasible if there is sufficient political will and courage. We refer to these as “sweet spots.” They include regulatory actions aimed at

reducing cars and freight in urban areas, such as low-emission zones, freight transport restrictions, and parking regulations and pricing; specific infrastructure initiatives such as intermodal mobility hubs; personal travel management measures including smart parking solutions or MaaS apps; and marketing strategies that promote sustainable mobility. The importance of effective marketing cannot be overstated, particularly when considering the marketing spend by the automotive industry. private companies and public organisations can also play a key role in promoting sustainable mobility behaviors among their employees through initiatives such as mobility plans or mobility budgets.

RETHINKING THE MOBILITY FUNDING EQUATION

Expanding mass transit, especially into less densely populated areas, requires significant investment because of higher marginal costs per passenger. Similarly, transitioning to net zero and enhancing resilience require considerable financial resources for fleet electrification, new e-vehicle infrastructure, and the maintenance or replacement of existing infrastructure. Solving the financing gap will require concerted efforts on both sides of the “mobility funding equation” — identifying new funding sources and enhancing the effectiveness and efficiency of expenditures.

7. “Future of Mobility Worldwide Survey (Q4 2023).” Arthur D. Little, forthcoming 2024.

On the expenditure side, transport authorities must focus on maximizing the cost-effectiveness (value for money) of capital investments. This involves prioritizing funding toward the most efficient transport modes based on their usage rates and cost-effectiveness. Additionally, cultivating new mobility as part of the menu might necessitate partial public funding, especially in areas where these services enhance the overall mobility system but may not yet be commercially viable. This must be complemented by operational efficiency measures to reduce operational costs.

Effective revenue management is crucial, particularly in fare policies, which typically generate 30-50% of total revenues. Exploring subscription models (including within a broader MaaS framework), enhancing service appeal by improving time competitiveness, and increasing the cost of car usage are viable strategies. Diversifying to identify new sources of revenue is also relevant. Additionally, exploring all available public financing options (e.g., the European Investment Bank in Europe) and fostering innovative public-private partnerships can provide both financial resources and operational benefits. However, it is essential to recognize that revenues ultimately come from only two sources: users and taxpayers. Successful public-private collaborations require a mutual understanding and acceptance of private sector expectations for a reasonable ROI.

PUTTING IT ALL TOGETHER — OVERALL CONCLUSIONS

The potential for transformation is evident, **yet the real challenge lies in putting it into action**. Insights from our Q4 2023 survey of mobility leaders⁸ reveal significant discrepancies between the acknowledged importance of these solutions (an average importance rating of **81%**) and the current readiness of the ecosystem to implement them (an average readiness rating of below **60%**). Therefore, system-level coordination and enablement are imperative to bridge this gap and turn potential into reality — there are no shortcuts.

Local and regional authorities must reevaluate their roles in shaping and guiding mobility ecosystems. This means moving beyond their foundational “**framing**” activities, such as putting in place a forward-looking mobility vision and suitable regulatory frameworks/policies, toward “**enabling**” activities. This includes steering and orchestrating roadmaps to facilitate the implementation of solutions that necessitate a multi-stakeholder approach guided by users’ actual problems and needs and requiring innovative public-private partnerships. For example:

- Roadmaps to facilitate the setup and implementation of a MaaS ecosystem.
- Adopting a comprehensive, system-level approach to autonomous transportation, integrating automated public transport with individual transport modes such as robo-taxis.
- Undertaking specific roles or actions that serve the wider public interest. An example of this is the future necessity for a “control tower” role in urban centers, which will be essential for the real-time management of traffic flows and transportation assets.

Achieving this will require expanding mandates and capabilities for authorities and developing more agile operational methods.

The solutions necessary for a transformative shift toward a more virtuous mobility future are already within our grasp, with clear “game changers” already identified to accelerate the transition. Making it happen demands political will, courage, and determination. Increased collaboration among public and private stakeholders within the extended mobility ecosystem is key. Transport authorities in cities and regions, in particular, play a crucial role in accelerating the shift.

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