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# Smart Transportation

## Paving the way to greener, smarter, and more sustainable cities

January 2022

# Smart transportation: Paving the way to greener, smarter, and more sustainable cities

**According to the International Transport Forum, passenger transport will increase nearly three-fold, from 44 trillion in 2019 to 122 trillion passenger-kilometers in 2050.[1] The International Energy Agency (IEA) predicts three times more passenger movement globally by 2050. [2] By 2050, 70 percent of the world's population will live in cities and more than 30 percent of global energy demand will originate from transportation sector. [3]**

With transport contributing around five percent to the European Union (EU) Gross Domestic Product (GDP) and employing more than 10 million people in Europe, the transport system is critical to European businesses and global supply chains. At the same time, transport is not without costs to our society, including greenhouse gas and pollutant emissions, noise, road crashes, and congestion. Today, the transport sector is the largest contributor of Greenhouse Gas (GHG) emissions within the EU, accounting for around 28 percent of total emissions and continues to report around 0.8 percent growth in metric tons of carbon-dioxide equivalent (MtCO2e) every year, with passenger cars accounting for the highest portion.[4]

Not surprisingly, reducing emissions from the transport sector is pivotal for Europe's success of becoming the first climate-neutral continent by 2050 and cutting emissions by at least 55 percent by 2030. Governments must agree on the right policies to incentivize citizens and companies to opt for more sustainable—or, greener—transport selection, and improve vehicle technologies and alternative fuels. To this end, the European Commission presented the Sustainable and Smart Mobility Strategy that lays the foundation for how the EU transport system can achieve its green and digital transformation and become more resilient to future crises. This strategy is in line with the ambition of the European Green Deal and the objectives of the EU's Digital Strategy.

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1. Source: International Transport Forum, "Transport demand set to triple, but sector faces potential disruptions", 22 May 2019
2. Source: International Energy Agency (IEA), "The Future of Rail – Opportunities for energy and the environment", January 2019
3. Source: International Energy Agency (IEA), "The Future of Rail – Opportunities for energy and the environment", January 2019
4. Source: McKinsey & Company,"Built to last: Making sustainability a priority in transport infrastructure", October 1, 2021, Luca Milani, Detlev Mohr, and Nicola Sandri

"To reach our climate targets, emissions from the transport sector must get on a clear downward trend. Today's strategy will shift the way people and goods move across Europe and make it easy to combine different mode of transport in a single journey. We've set ambitious targets for the entire transports system to ensure a sustainable, smart, and resilient return from the COVID-19 crisis."

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Franz Timmermans, Executive Vice-President for European Green Deal

As part of the European Green Deal, the European Commission released the Fit for 55 legislative package, which aims to put Europe on course to be the first climate neutral continent by 2050. This important legislative package will strengthen policies on renewable energy, energy efficiency, land use and more; it also aims to fortify sustainable transportation. To achieve the aspirations in the European Green Deal, there needs to be a shift and refocus to more sustainable transportation solutions, such as greater use of electric vehicles, bicycles, shift of today's inland freight carried by road onto rail and inland waterways but this means putting users first and providing them with more affordable, accessible, healthier, safer, and cleaner alternatives.[5]

This push to transform transportation comes at a time when the entire sector is still reeling from the impacts of Covid-19. With increased public and private investment in the modernization and greening of the existing infrastructure to stimulate economies and their recovery, we now have a historic opportunity to make European transport not only more sustainable but more competitive globally and more resistant to any future shocks.[6] According to McKinsey & Companies Global Infrastructure Outlook, more than $2 trillion of transport infrastructure investments worldwide will be needed each year until 2040 to fuel economic development.[7]

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5. Source: The European Commission, Mobility Strategy "A fundamental transport transformation: Commission presents its plan for green, smart and affordable mobility"
6. Source: The European Commission, Mobility Strategy "A fundamental transport transformation: Commission presents its plan for green, smart and affordable mobility"
7. Source: McKinsey & Company,"Built to last: Making sustainability a priority in transport infrastructure", October 1, 2021, Luca Milani, Detlev Mohr, and Nicola Sandri

As announced by Ms. Ursula von der Leyen, the president of the European Commission in June 2021, the EU member states have collectively €723.8 billion in loans and grants under the Recovery and Resilience Facility (EU RRF) to support reforms and investments undertaken by the EU member states to help them become more sustainable, resilient, and better prepared for the green and digital transitions. More specifically, the EU member states have collectively allocated €85 bn to sustainable transport as part of the National Recovery and Resilience Plans being developed to support the recovery from the Covid-19 pandemic.[8] Among the areas identified as having priority for investment and reforms as part of the EU RRF, the recharge and refuel flagship is most relevant for transportation as it focusses on the promotion of future-proof clean technologies to accelerate the use of sustainable, accessible, and smart transport, charging and refueling stations and extension of public transport. More specifically, the leading EU ambition is to have 1 million charging points and 500 hydrogen stations installed by 2025.[9] This presents itself as an opportunity for Europe to build a greener, more sustainable, smart, and resilient transportation network: a system for future generations.

Digitalization will become an indispensable driver for this modernization. To this end, we see increased take up and attention to smart cities, smart mobility (such as promoting clean collective transport), and smart solutions for cities. Innovation and digitalization will shape how passengers, freight, and cars move in the future. We expect to see a surge in investment and innovation in electric vehicles, the battery value chain, renewable hydrogen technology, and sustainable alternative transport fuels.

Commissioner for Transport Adina Valean said:

"As the backbone that connects European citizens and business, transport matters to us all. Digital technologies have the potential to revolutionise the way we move, making our mobility smarter, more efficient, and also greener. We need to provide businesses a stable framework for the green investments they will need to make over the coming decades. Through the implementation of this strategy, we will create a more efficient and resilient transport system, which is on a firm pathway to reduce emissions in line with our European Green Deal goals."

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8. Source: International Railway Journal, "€85bn for sustainable transport included in EU recovery plans", June 8, 2021, David Burroughs, Article
9. Source: European Parliament, "Transport trends in national recovery and resilience plans", November 2021, European Parliamentary Research Service (EPRS), Briefings

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# Building greener, more sustainable, and resilient transportation model in cities

Most governments are investing in modernization of their existing transportation infrastructure and exploring strategies for reducing car use, promoting active mobility, investing in clean vehicles, and recharging infrastructure, as well as improving public transport. But the adoption of greener measures is gradual and it is questionable if these planned actions are sufficient to meet the 55 percent emission reduction by 2030.

Cities today are using communications and technology to improve traffic management for example. But the added stress of uncertainty when it comes to traffic, available parking slots and convenient payment systems in cities remains a challenge. The COVID-19 pandemic has worsened the situation even further, where commuters no longer have access to usual parking spots and look for alternative, safer, and digital mobility options. According to a recent study carried out by CapGemini, "76 percent of people surveyed currently perceive public transportation (e.g. bus and train) as unsafe or very unsafe"[10] when relating to public safety. We know that parking is a cause of concern in cities due to its impact on the environment, ranging from congestion to pollution. Smart parking technologies and solutions can help optimize parking space usage, improve the efficiency of the parking operations, allow for digital payment, identify available chargers for electric vehicles and help smoother traffic flow in cities. Only 11 percent of global public parking spaces (on-street and off-street) are now "smart."[11] There's a huge potential for this market to grow.

10. Source: CapGemini, "How COVID-19 is affecting car sales and consumer attitudes", May 14, 2020
11. Source: SmartCitiesWorld, "11% of global parking spaces now smart", December 27, 2018

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Reinforcing for smart parking and smart metering systems can drastically contribute to improving way of life, and lower carbon emission, giving rise to a cleaner environment and aid sustainable transportation. Investment in clean vehicles and recharging infrastructure can also support cities in achieving their greener ambitions. Many EU member states have embedded incentives to support the purchase of clean vehicles as well as investing in charging infrastructure for electric vehicles and refueling stations as part of their national plans under the EU RRF. New zero-emission buses are planned to be financed in 13 countries.[12] The Czech Republic wants to invest in battery trolley-buses and trams in Prague, and Estonia will support tram transport in Tallinn. Croatia also plans to modernize its tram fleet and introduce autonomous electric taxis adapted to people with disabilities. About half of governments intend to update, upgrade, or extend their existing national green mobility plans. Several have earmarked specific investment to increase cycling, either as a daily means of transport or as a sustainable form of tourism, or both. The specific targets, however, need to be weighed against each country's existing situation, national policies and incentives in place. [13]

Digital technologies and innovative solutions will play a fundamental role in keeping businesses competitive and more resilient in the new transport landscape and helping get closer to achieving Europe's net zero targets and solving climate change. Digitalization of transport networks should also render positive safety impacts as measures move towards safe, sustainable, and connected mobility from the exponential potential of cognitive technology that has the potential to save lives by preventing accidents and congestion, and avoiding disruption, particularly on roads and rail. Other digital elements in advancing road transportation could see a shift towards greater access to open data for smart mobility and deployment of the Mobility as a Service (MaaS) structures. Simultaneously, with the emergence of intermediary platforms, we are witnessing a move towards shared and collaborative mobility services (shared cars, bicycles, ride-hailing, and other forms of micromobility)[14], which are driving the reduction of vehicles in daily traffic. Funding from EU RRF will spur this, as many countries have embedded sustainable mobility plans in their national plans. Seamless multimodality enabled by innovative and digital solutions will be vital in urban and sub-urban areas [15] and the cornerstone for cities to achieve their sustainable goals.

In the following sections, discover insights about how cloud technology can strengthen the transportation sector in smart cities.

12. The 13 countries include: Belgium, Germany, Greece, Croatia, Italy, Cyprus, Latvia, Lithuania, Hungary, Malta, Austria, Poland and Portugal.
13. Source: European Parliament, "Transport trends in national recovery and resilience plans", November 2021, European Parliamentary Research Service (EPRS), Briefings
14. Micromobility refers to the use of lightweight vehicles such as bicycles or scooters, etc.
15. Source: The European Commission Sustainable & Smart Mobility Strategy, "Putting European transport on track for the future", 2021

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# Cloud technology for transportation sector

Using the cloud, organizations have already been able to reduce their carbon footprints. A new report by 451 Research, commissioned by AWS, found that businesses in Europe can reduce their associated energy usage by nearly 80 percent when they run their applications on the AWS Cloud instead of operating their own data centers. The report also found that migrating compute workloads to AWS across Europe could decrease greenhouse gas emissions equal to the footprint of millions of households. In addition, companies could potentially further reduce carbon emissions from an average workload—by up to 96 percent—once AWS meets its goal to be powered by 100 percent renewable energy, a target the company is on a path to achieve by 2025. Compared to the computing resources of the average European company, cloud servers are roughly three times more energy efficient, and AWS data centers are up to five times more energy efficient. In fact, moving a megawatt (MW) of a typical compute workload from a European organization's data center to AWS Cloud could reduce carbon emissions by up to 1,079 metric tons of carbon dioxide per year.[16]

Cloud technology facilitates the collection, secure storage, analysis, and dissemination of overwhelming amounts of traffic data generated in cities. The cloud enables agility, collaboration, and enhanced security. It creates an environment for experimentation and drives innovation. From managing traffic signals and intersection surveillance to smart parking and improved public transportation. State, regional, and local governments can harness the power of Internet of Things (IoT), machine learning (ML), and artificial intelligence (AI) to derive insights to build a resilient and sustainable transport infrastructure. Predictive analytics from data can help improve the efficiency of the parking operations and help smoother traffic flow in cities. It can also help to maintain sustainable and more resilient transport operations through disruptive events such as power outages, severe weather, traffic incidents, and cyberattacks, improving emergency preparedness and disaster response. The cloud can enable on-demand transportation options while also potentially reducing a citizen's environmental footprint. From rentable scooters, bicycles, transportation network companies (TNCs), and car share apps like Lyft and Uber, technology enables an easier experience for payment, booking, collection and drop off throughout cities. Journey apps like Moovit increase travelers' convenience by recommending fast, environmentally friendly, and convenient routes.[17]

16. Source: The Amazon blog, "EU businesses that move to AWS Cloud can improve energy efficiency and reduce carbon emissions", November 9, 2021, Day One Team; and 451 Research, "Saving Energy in Europe by Using Amazon Web Services", Commissioned by AWS, October 2021
17. Source: AWS Public Sector Blog, "Improving your commute, a cloud at a time: Transportation in the age of technology", January 21, 2020, Phil Silver

With fast-emerging concepts such as connected cars, cities have exciting new opportunities to address traffic challenges as cities can use the data to plan and better distribute traffic. A recent study by Tuxera suggests that a single connected car will send around 25GB of data per hour from its sensors,[18] which means that cities can leverage data for smarter planning and traffic management. For example, connected police cars or ambulances may send or receive data as they patrol the city and receive emergency calls. With this data, the emergency service and city planners can understand vehicle performance, maintenance needs, traffic patterns, and potential issues so that in turn operational teams can use the data to gather real-time insights and situational awareness based on data transmitted directly from the vehicle to ensure enhanced real-time planning. City planners and emergency services can use this data to adjust operation of traffic lights in real-time, to reduce the time it takes for an ambulance or police car to reach their destination.

Storage services like Amazon Simple Storage Service (Amazon S3) give customers the ability to store virtually an unlimited amount of data cost-effectively, whereas services like Amazon SageMaker make it easy to build, train, and deploy machine learning models at scale.

Edge computing is also very important for smart cities and smart mobility for achieving very low latency, mitigating risks of connectivity issues, and filtering what data is sent to the cloud.

Using cloud services, administrators have the opportunity to deliver on the promise of making our cities smarter, more responsive, and resilient, fulfilling the smart city promise: making lives of citizens more enjoyable, safer, and improving the overall quality of life of its residents.

18. Source: Tuxera, "Autonomous cars generate more than 300 TB of data per year" July 2, 2021, Simon Wright

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# Power of AWS IoT, ML, and AI

IoT technology connects thousands of devices located in homes, factories, cars, hospitals, and other places; it collects, stores, and analyzes device data. Connecting sensors, cameras, and other traffic devices to create an IoT and embedding AI can provide real-time insights for smart traffic management and smart maintenance, which involves monitoring road conditions such as potholes, roadworks and traffic flows including optimizing traffic lights. Through data analytics, these solutions can lead to reduction in reducing congestion in cities as well as other environmental, social, and economic benefits such as improvement of traffic flows and reduction of noise and pollution.

Across the globe, AWS works with leading transportation technologies to build cloud solutions for airports, seaports, mass transit, tollways, municipal planning, parking authorities, motor vehicle departments, traffic management departments, and departments of transportation. Companies like Iteris and Parsons are using cloud analytics and machine learning to create scalable and secure solutions to help cities improve mobility and make effective decisions for high-impact traffic events. Gridsmart and Miovision use the IoT and computer vision on the cloud to speed travel and improve the safety of intersections. MOIA developed innovative technologies for ride pooling solutions using AWS IoT Core to send information on hundreds of metrics, including key automotive telemetry and AWS IoT Greengrass for a seamless functionality while offline due to tunnels and other geographical inhibitors. With real-time fleet data, MOIA can reallocate empty vehicles to predicted demand areas, more evenly spread out vehicles, and reduce mismatch between demand and supply.

Cities can take advantage of these cloud technologies and AWS Cloud's capacity to store and analyze petabytes of data in data lakes. Data lakes are ideal for storing and processing traffic data at this scale. AWS provides a comprehensive, secure, and cost-effective portfolio of services that enable customers to build their data lake in the cloud and analyze all their traffic data with the broadest set of analytical approaches.

Embedding AI and IoT together can make devices more intelligent. AI can be used to analyze video data and sensor data and discover insights to optimize how traffic is flowing through roadways. The AWS IoT solutions are scalable, adaptable, and cost-effective to connect devices, ingest and analyze data. Using real-time data streaming, the AWS IoT services can work in combination with Amazon S3 for data storage, Amazon Kinesis Video Streams for real-time video streaming, Amazon SageMaker for ML, and Amazon Alexa's voice technology. Together, the services can derive actionable insights such as alerting smart parking systems in surface parking lots in shopping malls, train stations, corporate campuses, and more. Voice technology is ideal for citizens with disabilities as it offers the potential of an easier and safer way of getting around the city. Real-time data analytics and voice technology can enable systems to detect parking space availability.

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Additionally, governments can leverage the AWS IoT Serverless managed services to improve many aspects of city life that's important to citizens, such as air quality, flood control, and waste management. For example, Miovision Spectrum is a regional municipality in Canada that was looking for ways to respond faster to accidents and maintenance incidents, improve traffic planning, and reduce operational costs. It implemented Miovision Spectrum, which connects and optimizes traffic signals in cities, along multiple traffic corridors. It combined streaming video, sensor data, and analytics to achieve these improvements. The cities in that region now receive real-time alerts when there are significant changes to traffic flow and can verify whether an incident has occurred using streaming video. Transit and emergency medical personnel are alerted to slowdowns, and technicians and responders can be deployed instantly.

The traffic counts the cities rely on for planning, modeling, and signal evaluation—performed every three years prior to implementing Spectrum—can now be collected at any time to support traffic improvements. According to Dave Bullock, managing director at Miovision, they *"helped customers discover insights to optimize how traffic is flowing through roadways." "Using artificial intelligence to analyze video and sensor data means cities can now understand the impact of intersection changes in as little as a few days, which fundamentally changes how they test and improve the effectiveness of their infrastructure,"* says Bullock. Using Miovision technology, cities can manage traffic infrastructure in real time, alert traffic engineers and emergency-response teams when problems are detected, and even automatically change traffic signals to get emergency personnel to accident scenes faster. Efficient movement can also positively affect the environment. Miovision customers have projected exhaust-pollution reductions of as much as 10 percent by getting people to their destinations in less time with less idling.

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# AWS open data and open source initiatives

Cities of any size can benefit from creating open data. In London, access to data is facilitating transportation for city commuters. When Transport for London (TfL) opened up access to data, application developers and researchers used it to create more than 600 applications providing services to 42 percent of Londoners—from getting real-time traffic information to finding charging stations for zero emission capable (ZEC) vehicles in the city. Eighty-three percent of Londoners use TfL website with similar data: this benefits all transport users in the Capital, TfL itself, and supports London's economic agenda. Transport for London estimates that opening up data has resulted in saving up to £130 million per year for travelers, London, and TfL itself.

To make open source solutions easier to find for governments, AWS recently created an online repository: Open Government Solutions. These resources developed by the public sector can help government agencies at the local, regional, and national levels find solutions that have worked for others so that they can accelerate their digital transformation.

Additionally, Amazon Sustainability Data Initiative (ASDI) leverages AWS technology and scalable infrastructure to stage, analyze, and distribute data, as a joint effort between the AWS Open Data and Amazon Sustainability teams. ASDI provides cloud grants to those interested in exploring the use of AWS's technology and scalable infrastructure to solve big, long-term sustainability challenges with this data. The AWS Open Data program already makes numerous datasets available for public use through its Registry of Open Data on AWS.


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# Conclusion: The road ahead for the European transport sector

The recovery from the COVID-19 pandemic with the stimulus packages from the European Commission and private sector investment on green transition, underlining the increased focus and importance placed on climate change and decarbonization, provides a historic opportunity to make European transport not only more sustainable, safer, and healthier for its citizens but more competitive globally and more resistant to any future shocks.

The "twin green and digital transitions should reshape the transport sector, redraw connectivity and re-energize the economy."[19] It will not be easy and for its success, it will need substantial increase of growth-generating investment from public and private sectors as well as the implementation of policies and incentives to ensure citizens and companies opt for more sustainable and greener solutions to achieve Europe's net zero targets and solving climate change.

Increased investment in cleaner vehicles and fuels, the deployment of smart recharging and refueling infrastructure, the investment and use of renewables in the electricity grid, and increase in the price of carbon-intensive transport should see a shift to low-carbon alternatives. This, coupled with the potential of subsidies and incentives for consumer and companies, could further accelerate the transition by making clean mobility more affordable.

The investment in disruptive solutions will pave the way for important breakthroughs and environmental gains in the years to come. Innovation and digitalization are imperative. However, as outlined in the Commissions Mobility Strategy, the sustainable European transport system will need to "be smart, flexible and adaptable to ever-changing transport patterns and needs, based on cutting-edge technological advancements to provide seamless, safe and secure connectivity to all European citizens. Transport should showcase European ingenuity and industriousness—standing at the vanguard of research, innovation and entrepreneurship, and driving the twin transitions."[20]Private-public investment will also be a fundamental component to driving innovation and digital transformation.

By leveraging cloud for transportation services, cities can become faster, safer, and stronger. Empowered by cutting-edge digital advances, the cloud enables agility, collaboration, real time communication and analytics. It creates an environment for experimentation and drives innovation. From managing traffic signals and intersection surveillance to smart parking and improved public transportation. Cloud technology provides the security, scalability, and agility that local, regional, and national governments need to fulfil their mission and improve the lives of citizens.

19. Source: The European Commission, Mobility Strategy, "A fundamental transport transformation: Commission presents its plan for green, smart and affordable mobility", 2021
20. Source: The European Commission, Mobility Strategy, "A fundamental transport transformation: Commission presents its plan for green, smart and affordable mobility", 2021

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