International Transport Forum

How Improving Public Transport and Shared Mobility Can Reduce Urban Passenger Carbon Emissions

Scenario Results and Policy Findings

Reducing urban passenger emissions

Urban travel accounts for 40% of passenger transport's global carbon dioxide (CO_2) emissions and contributes significantly to local pollutant emissions in cities.[1]

Urban transport demand increases as income and population rise, and is dominated by privately owned vehicles. Private vehicles emit more carbon and consume more urban space than collective (public transport and shared vehicles) and active transport modes. As urbanisation increases, the increase of private vehicles limits accessibility and mobility.

Improving public transport services and incentivising the use of collective and active modes can make those modes more convenient, comfortable and accessible. Improvements for public transport can include more frequent services or higher operating speeds. Incentives to increase the supply of shared modes can include increasing licenses for ridesharing activities, or allocating urban space for shared-active modes. Such measures can enable a shift from privately owned vehicles to collective and active transport modes, reducing CO_2 emissions from the urban passenger transport sector as a whole.

This study looks at projections for urban passenger emissions if governments maintain current policies. Next, it presents two sets of urban passenger transport policy measures – one set for public transport, the other for shared transport modes – and the effects of each. It then looks at the effects of combining the two sets of measures in the Sustainable Urban Transport Supply (SUTS) scenario. Finally, the study presents the Integrated Sustainable Urban Mobility (ISUM) scenario, wherein the SUTS scenario is supplemented with improvement in infrastructure for collective and active modes.

[1] ITF (2021), ITF Transport Outlook 2021, OECD Publishing, Paris, https://doi.org/10.1787/16826a30-en.

Key findings

- Improving public transport service and operations alone sees a marginal increase in the share of public transport trips.
- Investing in shared modes can shift trips away from privately owned vehicles, but shared modes carry fewer passengers per trip than public transport, making them less productive. Shared-active modes are not attractive for longer trips.
- Policy measures to improve public transport combined with incentives for shared modes complement each other. Together, they shift trips away from privately owned vehicles to collective modes, resulting in an overall 4% decrease in emissions.
- Investing in infrastructure to prioritise collective and active modes increases the use of these modes. Combining infrastructure investment with improvements to public transport and incentives for shared modes results in an 8% reduction in emissions.
- Improving the efficiency of informal vehicles in emerging economies where they are most used can result in an additional 4% reduction in CO_2 emissions globally.

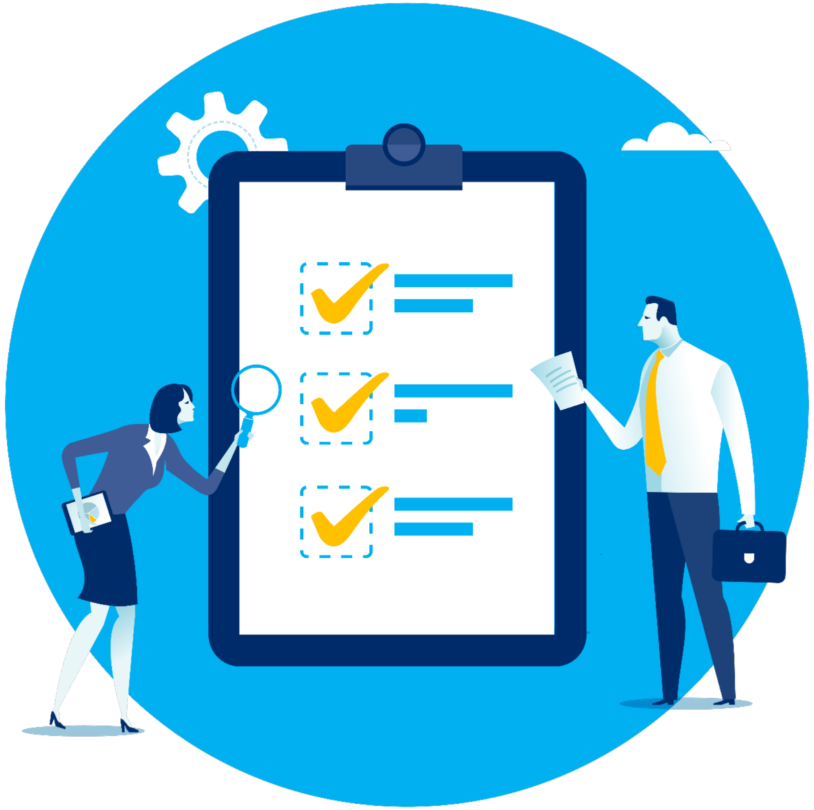
Glossary

Active modes	All non-motorised modes (e.g. walking, cycling, scooters, roller-skating, skateboarding) and electric-powered bicycles and scooters.
Collective modes	All public transport and shared vehicles (see "Shared modes" below), in contrast to privately owned modes.
Decide and provide	Supplying transport infrastructure and service to meet agreed-upon policy outcomes.
Informal modes	Privately operated and often unregulated shared modes (e.g. privately owned rideshare vehicles, minibuses, two- and three-wheelers) operating on a demand-responsive basis.
Paratransit	Public transport-like services operating under unclear regulatory frameworks. Paratransit includes informal and flexible-route bus services.
Predict and provide	Supplying transport infrastructure and service to meet forecasted future demand.
Private modes	Privately owned personal motorised modes (e.g. private cars and motorcycles); synonymous with "privately owned vehicles" in this slide deck.

Glossary (cont.)

Public transport	Publically operated or regulated fixed-route and fixed-schedule modes (e.g. rail, metro, light rail transit (LRT), Bus Rapid Transit (BRT), bus).
Regions	Africa: the entire continent of Africa Asia-Oceania: North, Central and the Caucasus Region, East and South Asia, the Middle East, Australia, New Zealand, the Pacific Islands Europe: All of Europe, including Türkiye LAC: Latin America and the Caribbean, including South and Central America US-Canada: United States, Canada.
Shared modes	Shared motorised modes operating on a demand-responsive basis (e.g. taxis, rideshare vehicles, taxibus); can include user-operated vehicles such as carsharing and motorcycle sharing.
Shared-active modes	User-operated shared non-motorised vehicles, as well as shared electric-powered bicycles and scooters.
Tank-to-wheel emissions	Emissions generated from the use of transport vehicles, also referred to as tailpipe emissions. They exclude well-to-tank emissions, which make up part of the total emission pathway. All references to emissions in this document refer to tank-to-wheel emissions.

Outline



1. Static baseline scenario and underlying drivers
2. Measures for public transport and shared modes
3. Sustainable Urban Transport Supply scenario
4. Integrated Sustainable Urban Mobility scenario
5. Paris Agreement targets still out of reach
6. Our modelling approach, measures and assumptions

Static baseline scenario and underlying drivers

The following section presents projections for the mode shares and CO_2 emissions by 2050 under the static baseline scenario. The baseline scenario assumes a "business-as-usual" approach to service improvements for public transport, investment in shared modes, and expected infrastructure developments. All other contributing factors remain unchanged after 2019.

The underlying drivers for urban passenger travel are also discussed. They include population and demand trends, supply of transport infrastructure, and vehicle efficiency and technology development.

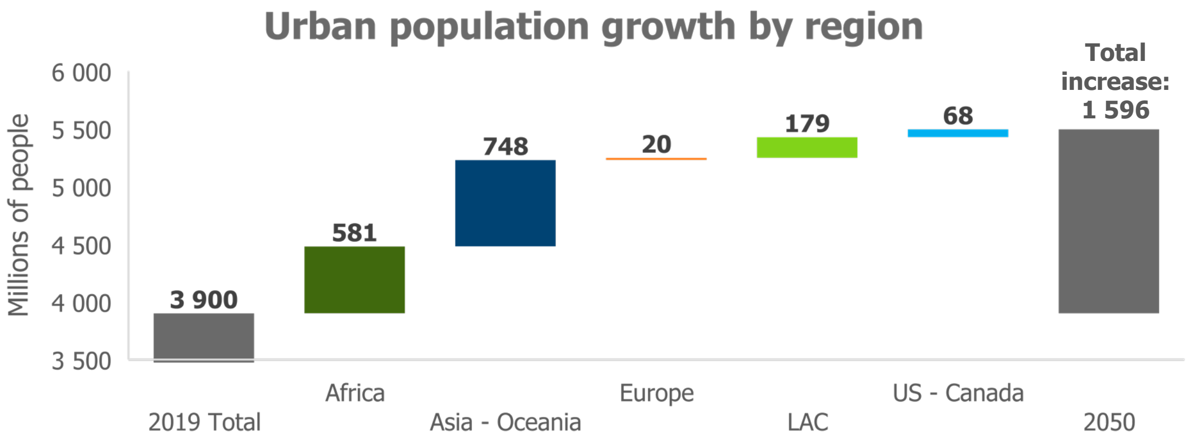
Population and transport demand grow

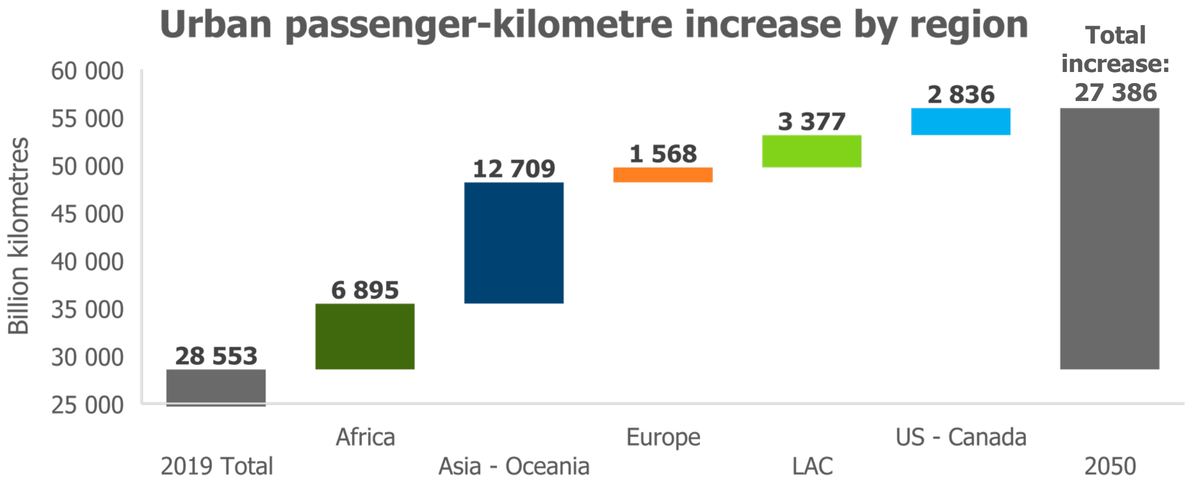
Urban population growth and the outward expansion of cities continue to increase passenger travel demand

The static baseline scenario is a benchmark for identifying the impacts of the enhancement measures and the SUTS and ISUM scenarios. This study uses 2019 as the base year, as the long-term impacts of the Covid-19 pandemic since 2020 remain unknown.

Despite the uncertainty surrounding the pandemic and future recovery, urban population growth is expected to increase by over 40% by 2050, and urban passenger travel demand will almost double in that period.

Where there are no geographic or regulatory constraints, increased urbanisation will cause urban sprawl. The rise in urban passenger-kilometres travelled illustrates this expansion.





Note: The growth trends are with respect to 2019.
LAC refers to Latin America and the Caribbean

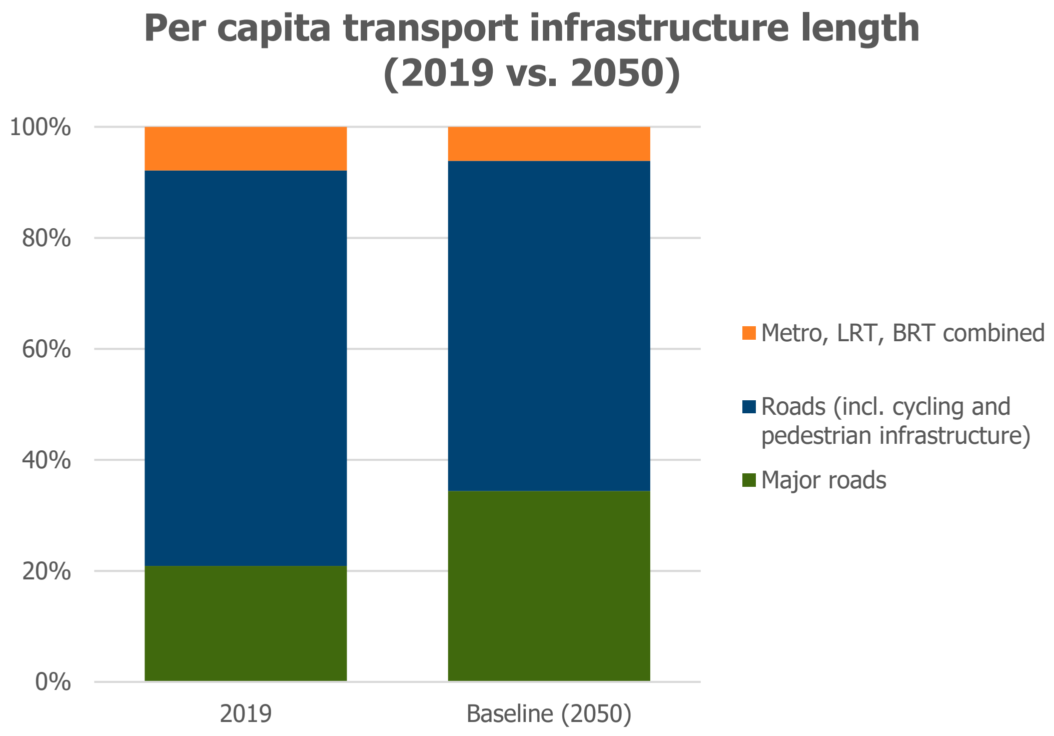
Supply of transport infrastructure is consistent

The predict and provide approach for transport infrastructure investment shows little change for low-carbon options

The supply of public transport infrastructure is significantly outpaced by population growth while roads are expected to grow in all regions at a faster rate than the population.

However, a high percentage of current roads can support cycling and pedestrian infrastructure, indicating an opportunity to boost infrastructure for active travel.

A shift towards a decide and provide approach for transport infrastructure investment can make collective and shared modes more attractive to users and result in a more productive transport system.



Note: *The baseline assumes a similar trend of new infrastructure supply and current infrastructure improvement observed in the past under a business-as-usual environment to support future travel demand.*

Vehicle technology improves over time

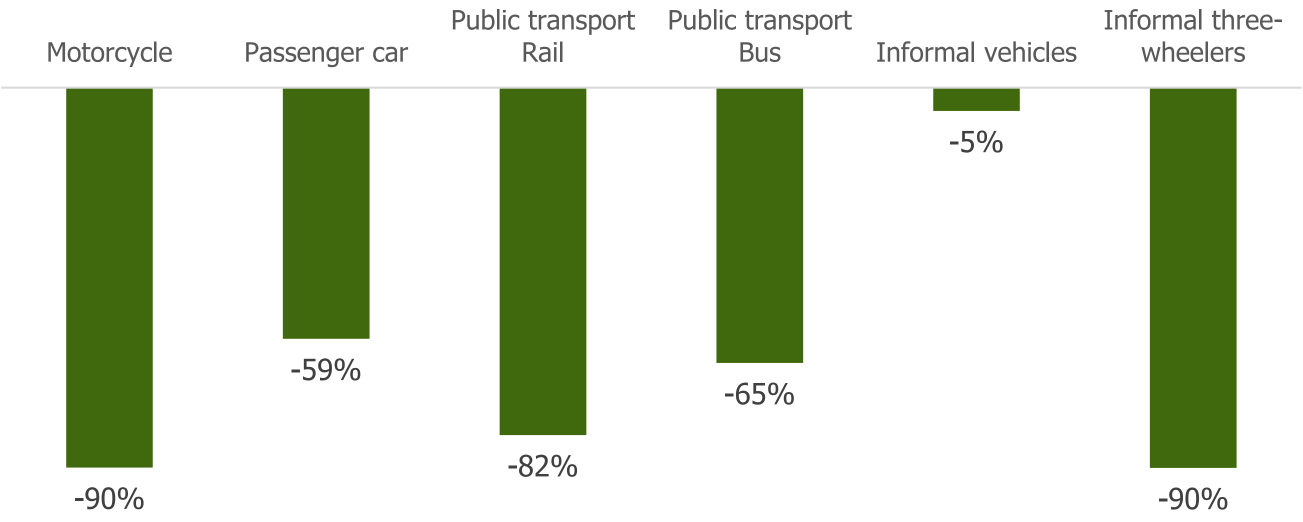
CO_2 emissions drop as vehicle technology and efficiency improve

Vehicle technology improvements play an important role in decarbonisation. However, regional differences in fleet composition - such as the vehicle's age and the uptake of zero emission vehicles (ZEV) – will result in different rates of CO_2 reductions across the globe.

Motorcycles and informal three-wheelers show the highest improvement in CO_2 emitted per passenger-kilometre, followed by public transport by rail. Public transport by bus (including BRT) and passenger cars also significantly decrease their CO_2 per passenger-kilometre.

Informal vehicles, however, will hardly improve in terms of vehicle efficiency by 2050 because they generally use much older fleets. They represent an opportunity for action to decarbonise the sector further.

Percent reduction in CO_2 emissions per passenger-kilometre from 2019 to 2050



Notes: *Trends are with respect to 2019.*
Active, shared-active modes, light rail transit and metro have zero tailpipe emissions.
Passenger car includes taxis, carshare and rideshare vehicles.

CO_2 emission reductions fall short of target

The 23% decrease in urban passenger transport CO_2 emissions projected for 2050 still falls short of Paris Agreement targets

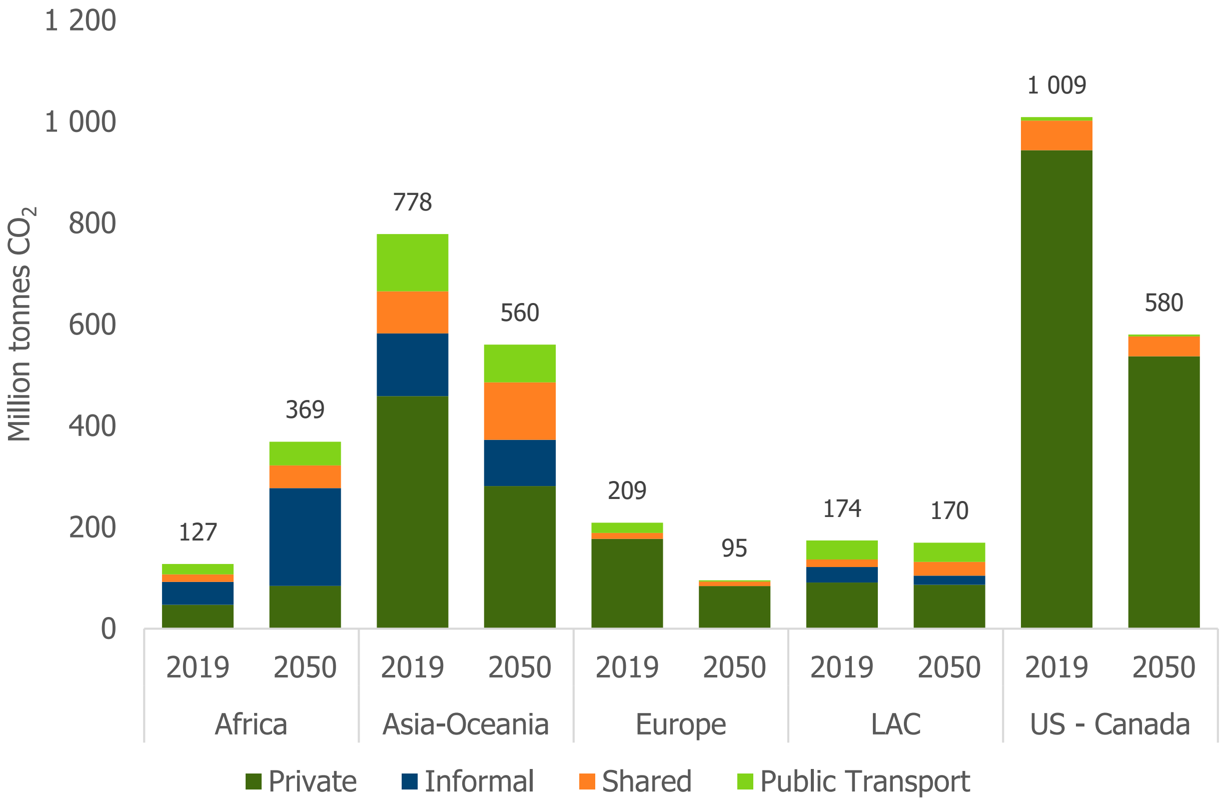
Privately owned vehicles will continue to dominate urban passenger transport CO_2 emissions in most regions in 2050.

Despite increases in urban passenger travel demand, all regions with the exception of Africa will experience a decrease in CO_2 emissions due to the combination of:

- expected improvements in vehicle efficiency and technology
- policy interventions to shift trips to low-carbon modes
- a higher emphasis on land use policies that decrease trip lengths.

Africa deviates from this trend largely due to its expected rate of urbanisation.

CO_2 emissions by mode and region



Notes: Growth trends are with respect to 2019.
Active and shared-active modes have zero tailpipe emissions.
Informal modes are not available in Europe and US-Canada.

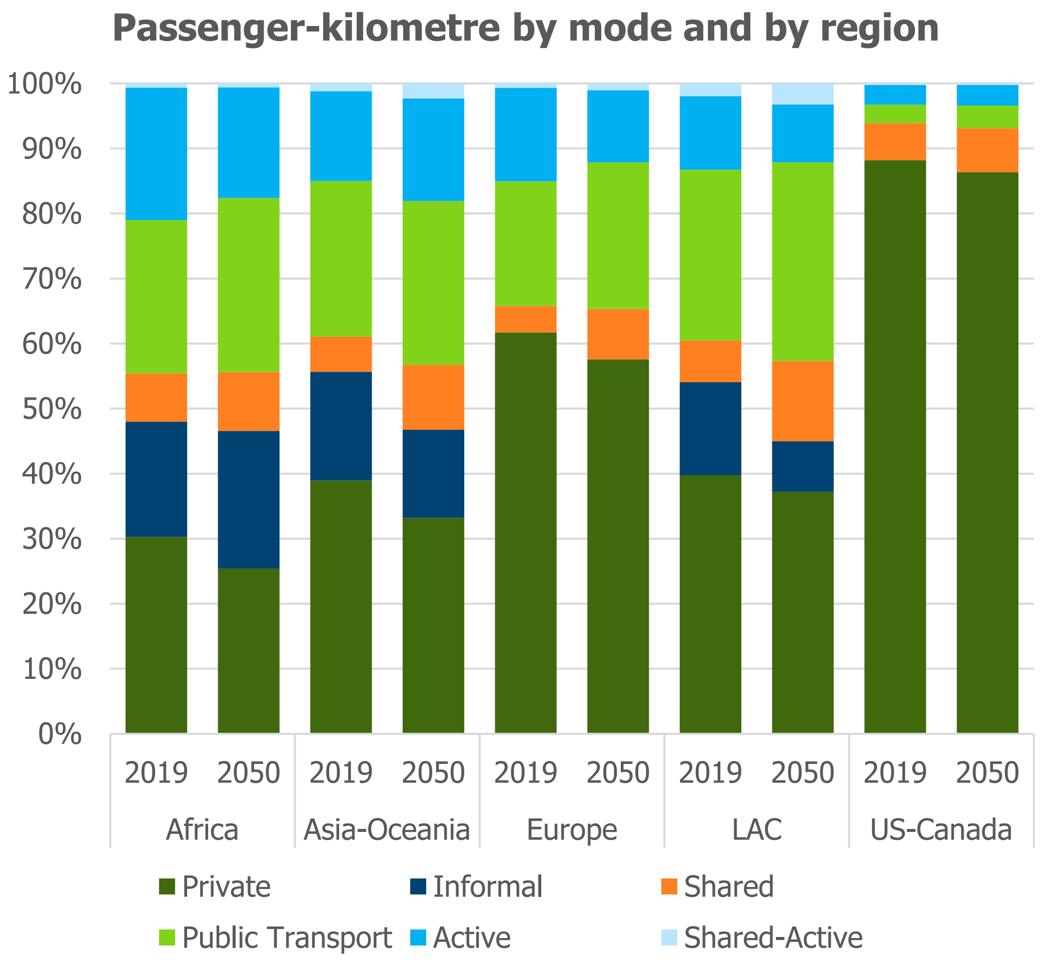
Mode share remains unchanged

Privately owned vehicles still dominate urban passenger transport in 2050

Sustainable modal splits between 2019 and 2050 see little improvement in the static baseline scenario. Active modes experience a downward trend in some regions and privately owned vehicles continue to dominate. Policy interventions that shift more people toward active and shared modes are necessary to reduce the carbon intensity of urban travel, particularly in regions with high private-vehicle dependency.

For example, the US-Canada and Asia-Oceania regions have distinctly different development patterns and mode shares than the other regions. Passenger-kilometres per capita in US-Canada is nearly double that of Asia-Oceania, alluding to the differences in land use and density in the two regions.

By 2050, 86% of passenger-kilometres in US-Canada will be driven by privately owned vehicles compared to 33% in Asia-Oceania. As a result, Asia-Oceania has the lowest per capita emissions globally, while US-Canada has the highest (almost nine times higher per capita emissions in 2050).

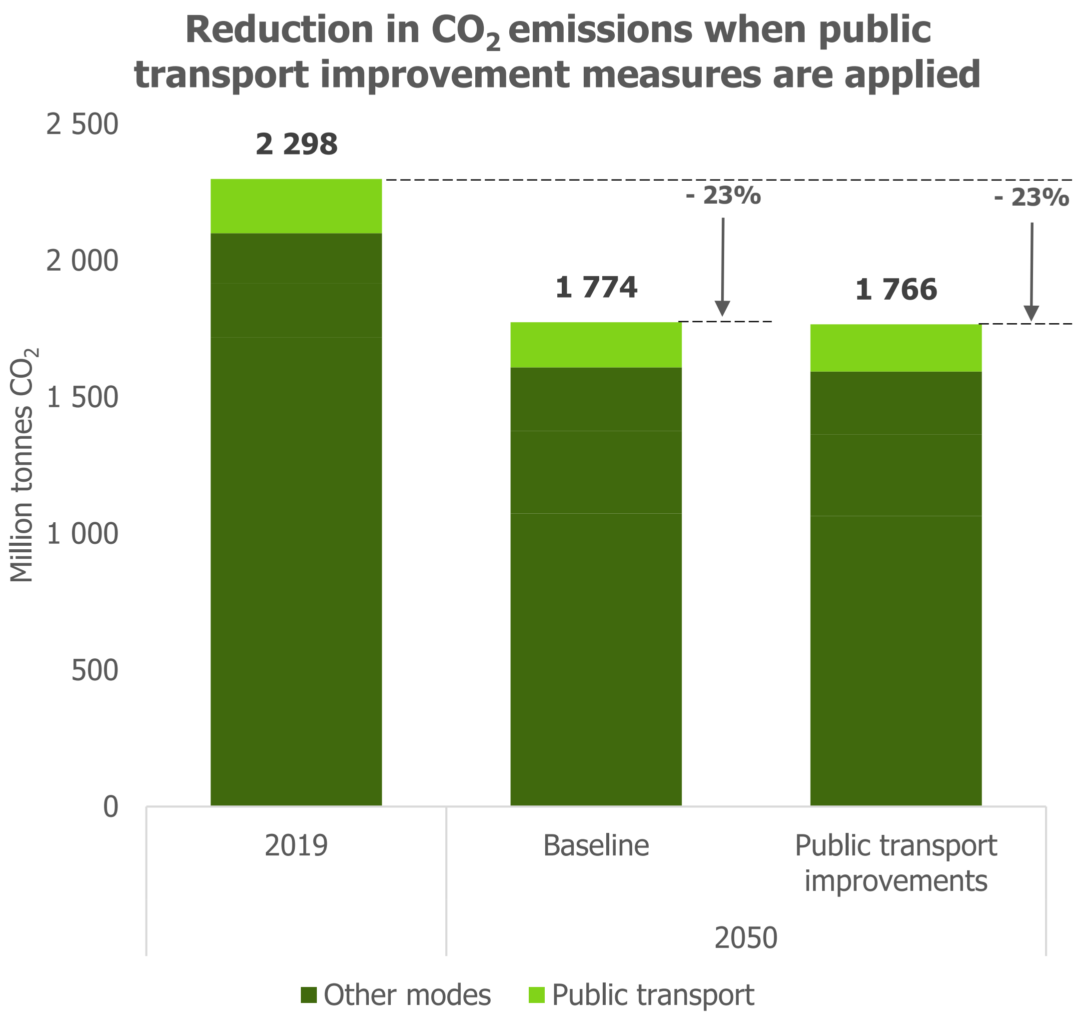


Policy measures for public transport and shared modes

The following section presents the impact on mode shares and CO_2 emissions when all policy measures from this study are applied to public transport and to shared services.

It also discusses some potential impacts of these measures on the liveability of cities and urban areas.

The impact of public transport service improvements



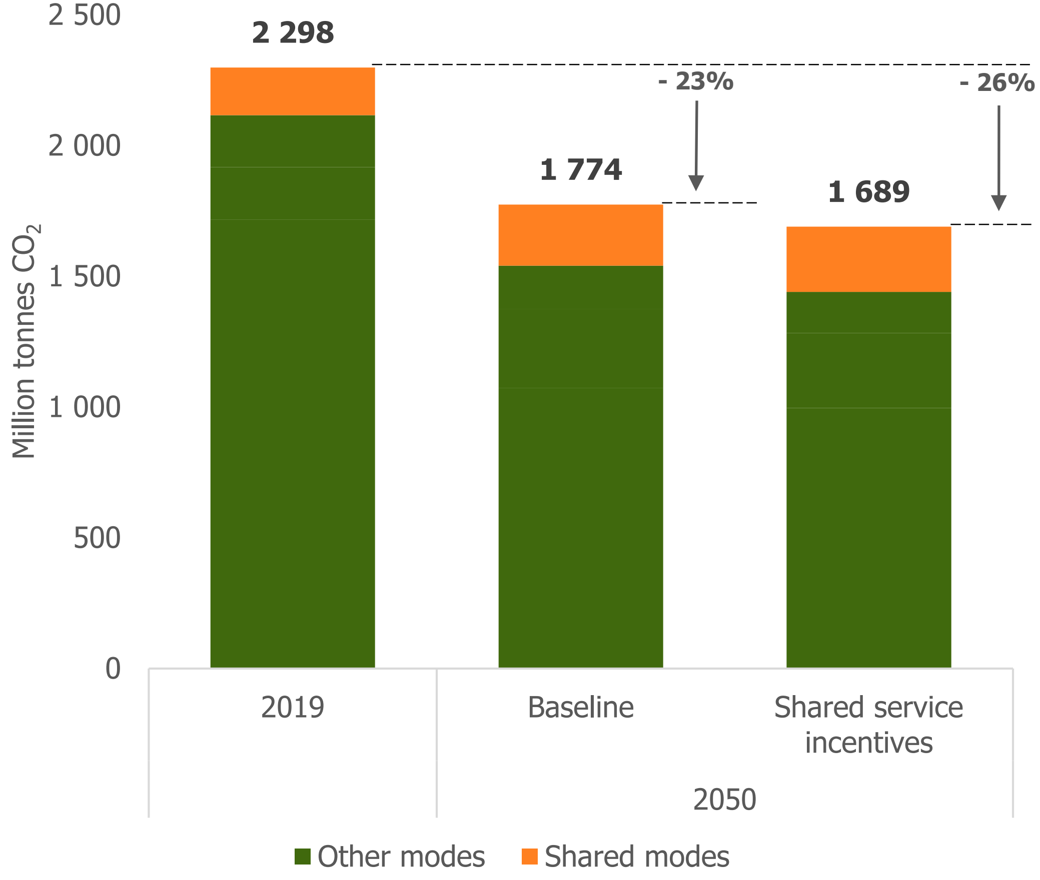
Public transport use increases slightly if the measures to improve speed and integrate services are applied. However, it does not have a significant effect on CO_2 emissions.

Increasing the average speeds and enhancing service integration to make fare payments and transfers easier for all public transport modes increases the mode share of public transport by just under one percentage point globally. The share of privately owned vehicles decreases by half a percentage point with these measures in place.

Public transport can deliver higher passenger-kilometres for a comparable amount of CO_2 emissions compared to priviate modes, limiting the impact on emissions from service improvements alone. Additionally, population growth and urban sprawl in cities significantly outpace the increase in public transport infrastructure, making the mode less accessible. This reduces the availability of public transport to users in comparison to other modes – particularly private modes. Service improvements for public transport will need to be accompanied by increased coverage to maintain the accessibility of the mode in growing cities.

The impact of shared services incentives

Reduction in CO_2 emissions when shared services incentive measures are applied



Applying incentives for shared services increases the use of shared services by almost three percentage points and decreases CO_2 emissions by nearly 4% compared to the 2050 baseline scenario.

Incentives for carsharing, ridesharing and shared-active modes increase the supply of those modes. Mobility as a Service is also included as one of these measures, as it facilitates the integration of information, payment, and shared services. The combined incentives result in a shift toward shared modes from privately owned vehicles (which sees a decrease of just over one percentage point) and public transport and informal modes (which, combined, see a decrease of just over 1.5 percentage points).

Implementing these measures results in CO_2 emissions that are three percentage points lower than the 2050 baseline scenario results. These measures are most effective for shorter trips due to the distance threshold for shared-active modes. As cities sprawl to accommodate population growth, shared services may be less attractive for longer trips and consume more space to maintain supply, highlighting the need for an integrated multimodal transport network.

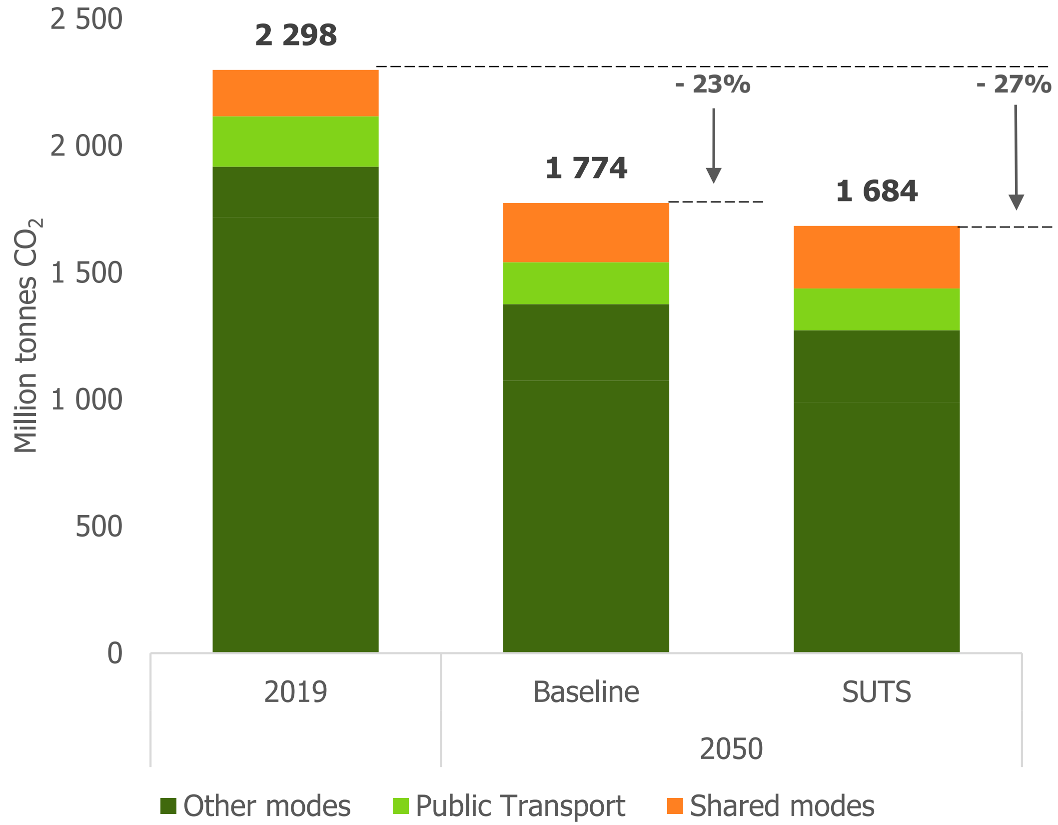
Sustainable Urban Transport Supply scenario

The Sustainable Urban Transport Supply (SUTS) scenario combines the service improvement measures for public transport and incentives for shared modes, to take advantage of their complementary nature.

Given the expected growth in population and travel demand as well as increased urbanisation, improving both public transport and shared transport will be necessary to maintain accessibility.

Sustainable Urban Transport Supply scenario reduces privately owned vehicles use and CO_2 emissions

Reduction in CO_2 emissions when public transport and shared modes improvement and incentive measures are applied in tandem



The Sustainable Urban Transport Supply (SUTS) scenario decreases overall CO_2 emissions by 4% compared to the 2050 baseline scenario.

The SUTS scenario, combining operational and service improvements for public transport with incentives for shared modes, has a slightly higher reduction in CO_2 emissions compared to implementing shared mode incentives alone.

This approach has a similar impact on the share of privately owned vehicles as the combined shared services incentives but a slightly less negative effect on the public transport mode share. SUTS also takes advantage of the complementary nature of shared modes and public transport. This approach is necessary given the population and travel demand growth trends, as well as the expansion of cities, which outpaces the expansion of public transport networks.

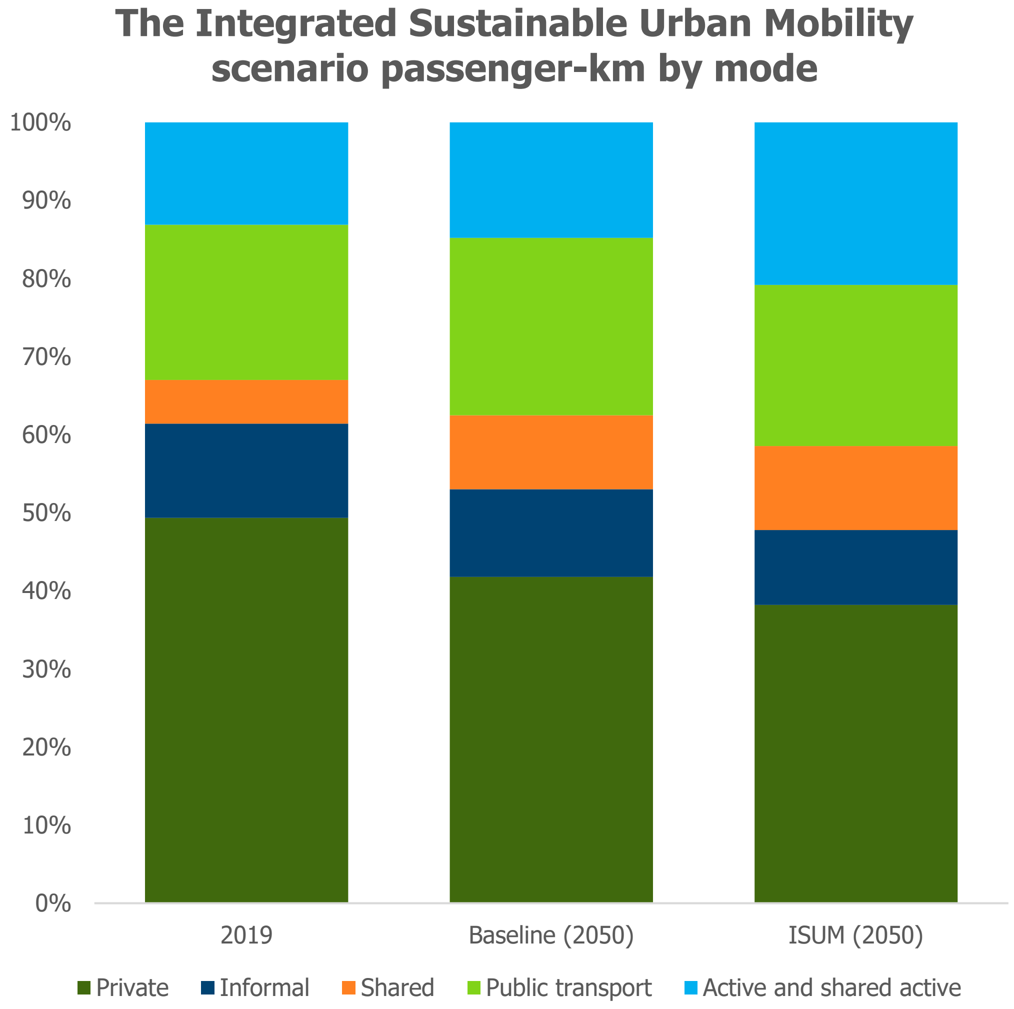
Implementing SUTS results in CO_2 emissions that are four percentage points lower than the baseline scenario results for 2050.

Integrated Sustainable Urban Mobility scenario

The Integrated Sustainable Urban Mobility (ISUM) scenario builds on the SUTS scenario by adding infrastructure investment to prioritise collective, shared and active modes.

By shifting more trips towards collective and active modes globally, even as the population and demand for urban travel grow, emissions can decrease. The city's structure also plays a role in this reduction: denser cities with a higher mix of land uses allow people to access opportunities within shorter distances.

The Integrated Sustainable Urban Mobility scenario and passenger-km by mode



Private and informal modes decrease in use in the ISUM scenario, and active and shared-active modes increase.

Global active modes, including shared-active modes, have the highest share of trips in the ISUM scenario (21% of passenger-kilometres) compared to the baseline scenarios of 2019 and 2050. This shift primarily comes from private modes (dropping from 42% in the 2050 baseline to 38% of passenger-kilometres) and informal transport (down from 11% in the 2050 baseline to 10% of passenger-kilometres). Both privately owned vehicles and informal modes are more carbon-intensive than other transport modes. In addition, they consume more urban space and worsen air pollution in cities.

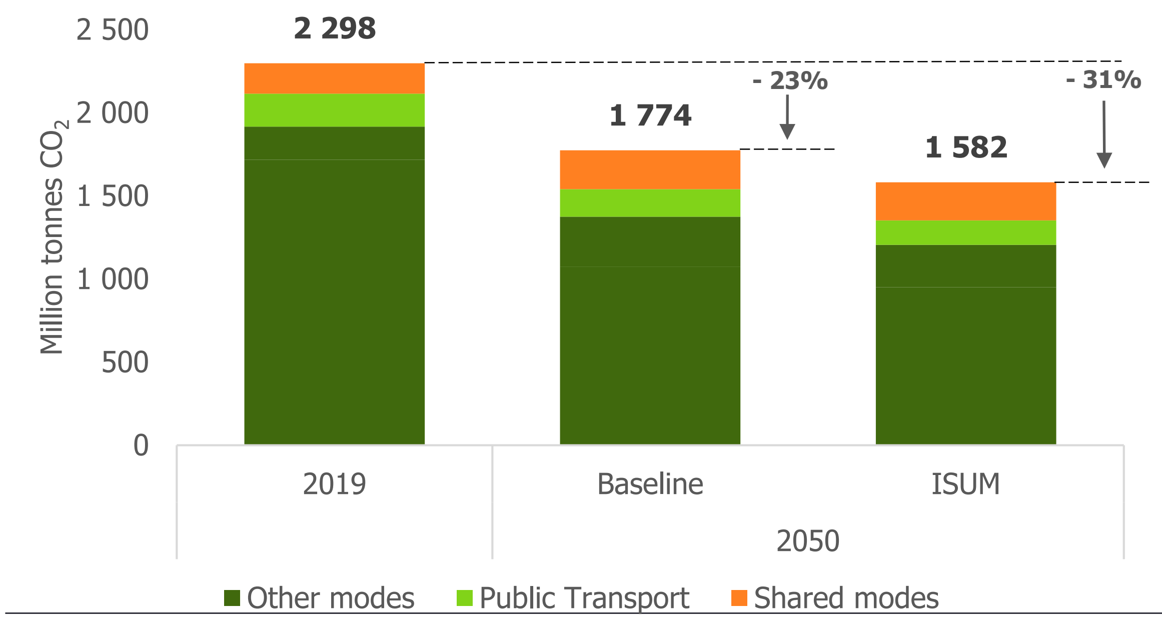
This scenario assumes additional investments to upgrade infrastructure for public transport and active modes, increasing the number and quality of priority and express lanes for public transport and adding cycling and pedestrian infrastructure. This approach improves the performance of collective and active modes and makes them more competitive with the more carbon-intense privately owned vehicles. A more integrated urban transport network also improves mobility as urbanisation increases.

The Integrated Sustainable Urban Mobility scenario and CO_2 emissions

The ISUM scenario can effectively reduce CO_2 emissions for urban passenger transport while better balancing the diverse travel needs of urban residents in growing cities.

Combining public transport improvements and shared service incentives with infrastructure investments that prioritise collective, shared and active modes significantly reduces emissions by shifting trips away from privately owned vehicles.

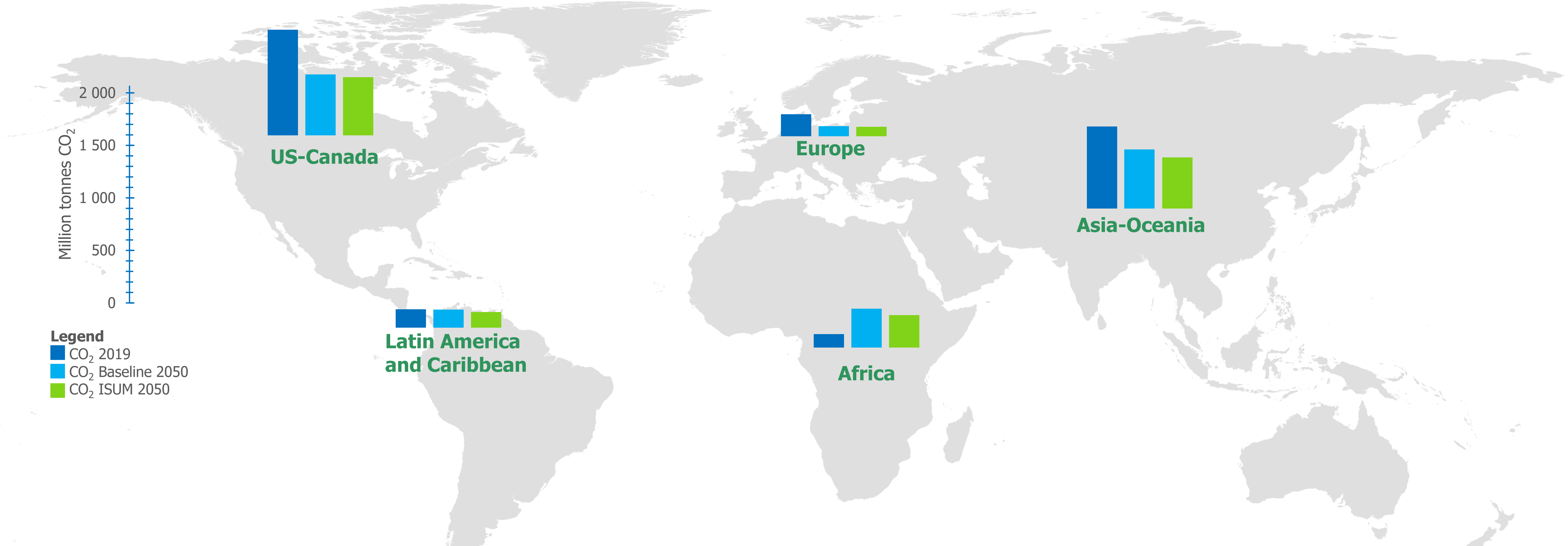
Reduction in CO_2 emissions by transport mode under the ISUM scenario



8%

lower CO_2 emissions in 2050 compared to baseline

The Integrated Sustainable Urban Mobility scenario and CO_2 emissions by region



The ISUM scenario results in lower carbon emissions for all regions. Shifting trips toward collective, shared and active modes has benefits beyond emissions reductions: less congestion, better air quality, and better overall health.

Paris Agreement targets still out of reach

In addition to the above policy measures, this study looked at the effect of improving the fleets used for informal transport. It found that doing so can significantly reduce CO_2 emissions in cities that use them.

However, even the full implementation of all the considered policy measures will not be enough to reach the Paris Agreement's decarbonisation goals. More must still be done.

Improving informal modes can help further decarbonise urban passenger transport

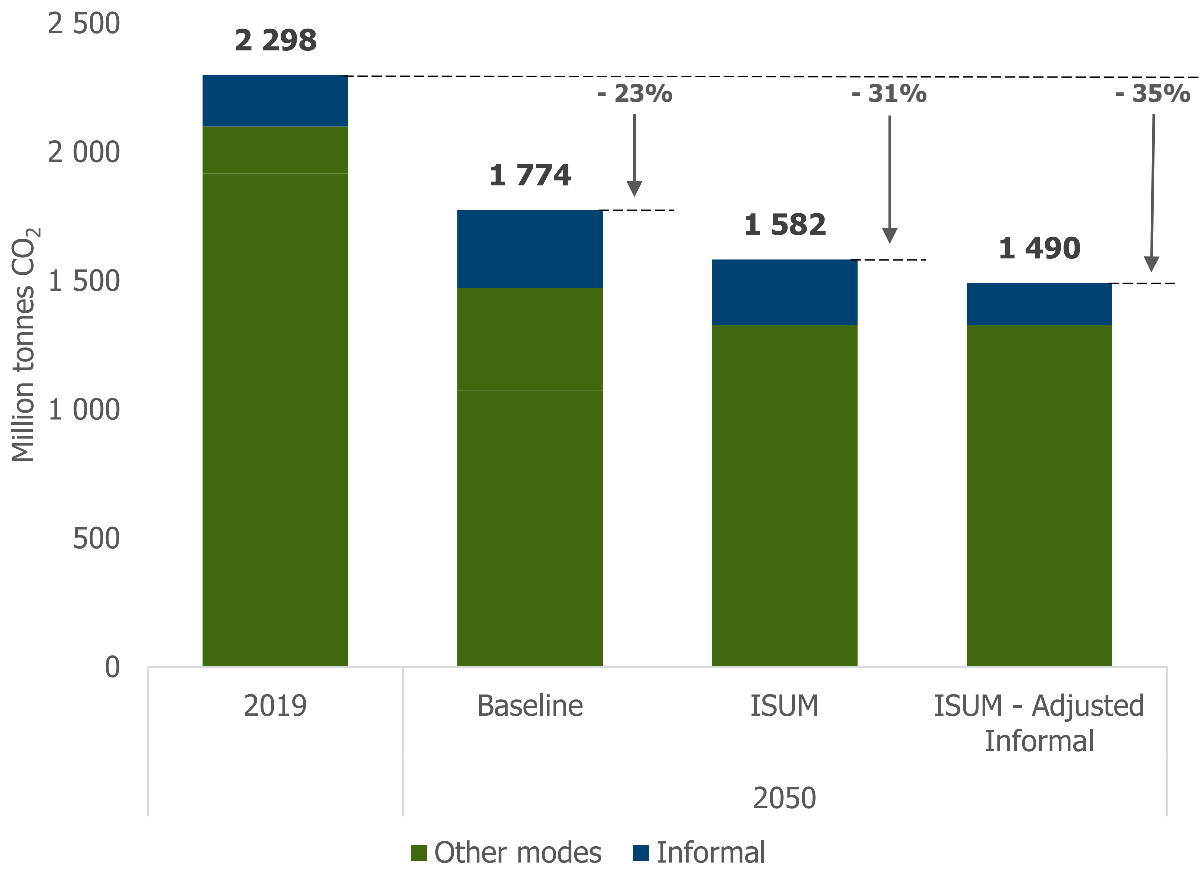
Improving the efficiency of informal modes can decrease urban passenger transport CO_2 emissions by an additional four percentage points in 2050.

Informal modes of transport exist due to a latent demand for better public transport service. Informal modes provide basic mobility and accessibility in places underserved by existing transport networks.

Actions to improve informal modes include allowing complementary operations between informal modes and public transport, integrating them into the public transport network and introducing regulations (e.g. emission standards) and incentives (e.g. scrapping schemes, purchase incentives) to improve the fleet's efficiency.

Overall CO_2 emissions would drop more than 12% compared to the baseline if the same rate of technology improvements were applied to informal fleets as is applied to formal bus transport in the ISUM scenario.

Reduction in CO_2 emissions when ISUM is combined with improvements to informal transport



Further policy interventions are needed to reach Paris Agreement goals

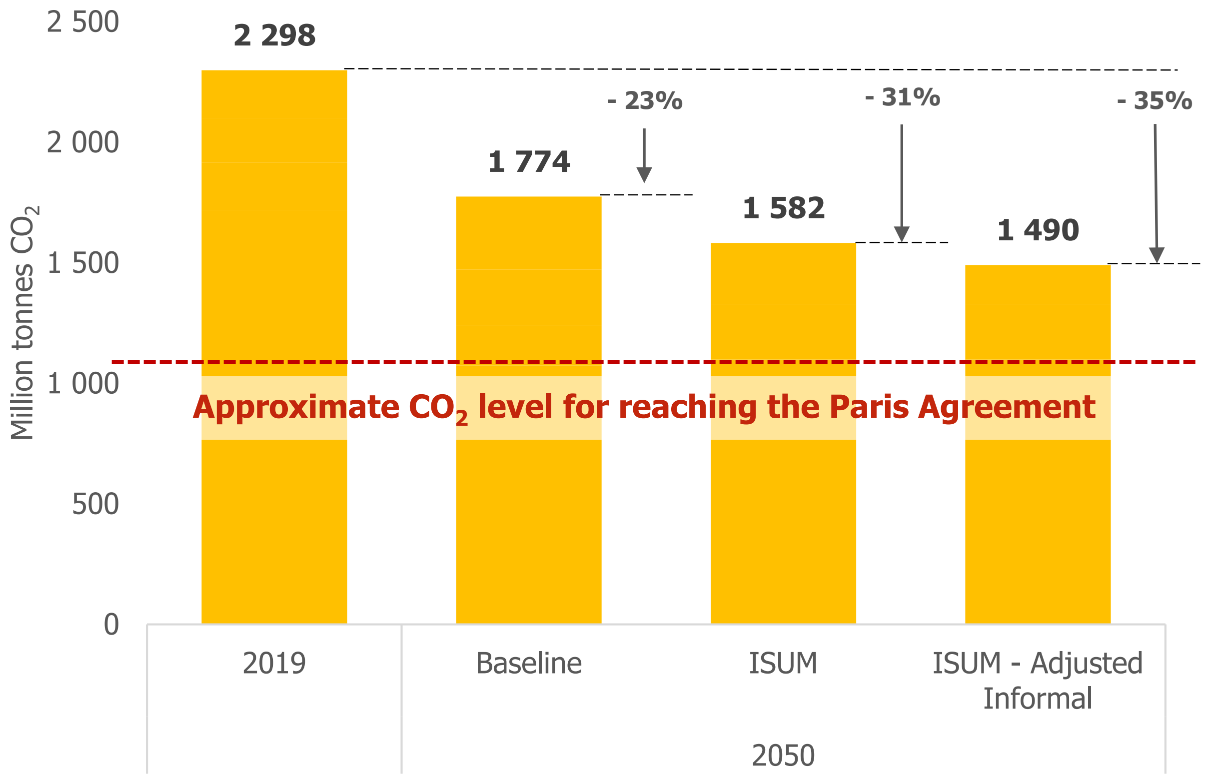
Combined improvement measures and infrastructure investments still fall short of the Paris Agreement goals.

More ambitious interventions will be needed to achieve further reduction in CO_2 emissions in urban passenger transport. The ITF Transport Outlook 2021 outlines ambitious interventions to reduce urban transport emissions, including pricing, regulatory, vehicle technology and infrastructure development measures.

With increasing urbanisation and a growing population, demand for urban travel will only continue to grow. Land use and investment in transport infrastructure will play a significant role in shaping the future of urban travel.

Enabling the use of collective and active transport for more urban trips will be necessary to achieve decarbonisation goals and make cities more liveable.

CO_2 emissions under baseline, ISUM and ISUM-Adjusted Informal scenarios compared to Paris Agreement goals



Our modelling approach, measures and assumptions

Our modelling approach consists of three steps:

1

Literature review and stakeholder consultation

Through literature review and stakeholder consultation, the ITF modelling team identified a list of effective improvements to public transport and shared modes and their potential impacts on mode share and CO_2 emissions. The same approach was applied to validate the scenario design and scenario outputs.

2

Scenario design

During the iterative process of scenario design, ITF modellers: 1) determined a list of effective measures; 2) identified the measures' expected impacts on the input assumptions of the ITF global urban passenger model until 2050; 3) assessed the impacts of individual and combined measures using the model; 4) modified the input assumptions as required.

3

Quantitative assessment

Based on the assumptions defined in the previous steps, the modellers used the ITF global urban passenger model to quantify sustainable transport supply enhancement scenarios and their impact on mode share and emissions. They compared the 2019 base year to the individual and combined scenarios results for 2050.

Our modelling measures and assumptions

Public transport service improvement measures

Service and operational improvements for bus and paratransit reduce overall travel times and increase travel speeds

- Measures include adjusting stop positioning, revising route alignments and adjusting frequencies.
  Informal buses see a 5% speed increase and formal buses a 20% speed increase by 2050. The maximum speed value cannot exceed car speed.

Service and operational improvements for BRT, LRT, metro and rail reduce overall travel times and increase travel speeds

- Measures include adjusting stop positioning, revising route alignments and adjusting frequencies.
  BRT average speed increases by 19%, LRT by 12%, metro and rail by 25% by 2050. The maximum speed is 25 km/h for BRT and LRT, 40km/h for metro, and 50km/h for rail.

Fare payment and service integration to reduce travel costs, decrease boarding times and improve transfers

- Measures include allowing off-board fare payments and simplifying transfers.
  5% reduction in public transport ticket costs, 8.5% reduction in public transport subscription costs, and 10% reduction in boarding times by 2050.

Shared service incentive measures

Incentives to increase shared-active mode supply (bike share, e-bike share, scooter share)

- Measures include supportive legal frameworks to allow operations, allocating urban space for vehicles, subsidies for operations.
  Up to 25% increase in the supply of shared-active mode vehicles by 2050, and increase the speed of bicycle mode up to 20% where e-bikes are in operation.

Incentives to increase carshare supply and shared trips option to reduce car ownership

- Measures include supportive legal frameworks to allow operations, preferred parking, subsidies for operations.
  5% to 30% increase in the supply of ridesharing vehicles by 2050, to correspond with a 10% reduction of car ownership for every 100 users.

Carpooling incentives to promote and increase shared rides and reduce car ownership

- Measures include preferred parking and differentiated tolls.
  8% to 17% increase in the average load factor for cars by 2050.

Shared service incentive measures (cont.)

Ridesharing incentives for standard vehicles to increase rideshare supply

Measures include supportive legal frameworks to allow operations, increasing licenses and simplifying permitting.
Non-linear increase in the supply of ridesharing vehicles; 20% decrease in population threshold to allow the operation of ridesharing and taxibus by 2050.

Pooled ridesharing incentives for minibuses (including taxibus and flexible-route buses) to increase supply and shared trips

Measures include supportive legal frameworks to allow operations, increasing licenses and simplifying permitting and differentiated tolls.
Non-linear increase in the supply and growth of taxibus vehicles and a 0.5 to 1.5 times increase in average taxibus load factors.

Mobility as a Service providing integrated fare payment options across public and shared modes and shared mode incentives

Measures include supportive legal frameworks to allow services and simplifying permitting.
7.5% to 45% increase in ridesharing vehicles, 5% to 30% increase in the supply of shared mode vehicles by 2050, and a lower income threshold needed to trigger the formalisation of informal transit.

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