

Technical Note

Unlocking the Power of Urban Transport Systems for Better Growth and a Better Climate

Xiao Zhao, Anjali Mahendra, Nick Godfrey, Holger Dalkmann, Philipp Rode, Graham Floater

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Summary for policy-makers

Sustainable transport systems are crucial for underpinning the economic performance and prosperity of nations. They are also critical for tackling global climate change, improving road safety and reducing local air pollution. This is particularly the case in the world's urban areas, as the majority of transport trips take place in and between cities. Each week, 1.4 million people are being added to urban areas, and urban travel constitutes more than 60% of all the kilometres travelled globally, the largest single source of global transport-related carbon emissions.

The business-as-usual pattern of urbanisation and transport mobility in many regions remains characterised by unplanned sprawl and inter-city and intra-city transport networks dominated by conventional motorisation. The complex interaction between urban development and transport connectivity has led to declining urban densities, a reduction in the share of non-motorised transport and public transport, and enormous growth in private vehicles. An area the size of Manhattan is being added to urban areas each and every day. A continuation of this pattern could lead to the global urban land area tripling and the number of motorised vehicles in the world doubling by 2030.

These trends have already created a wide range of economic, social and environmental costs, which can significantly constrain improvements in quality of life. The total social cost of Beijing's dependence on motorised transport, including congestion and air pollution, is estimated at 7.5–15.0% of GDP. China added 17 million new cars in 2014 alone. In the United States, work by the New Climate Economy (NCE) demonstrates that urban sprawl costs over US\$1 trillion per annum, including US\$400 billion in costs to the public purse and more than US\$600 billion in costs related to private vehicle use.



Photo credit: EMBARQ Sustainable Urban Mobility/Flickr

About this working paper

This paper is targeted at a wide readership, and we hope will be of interest to any public-and private-sector decision-makers, practitioners, non-government organisations (NGOs) or academics who have an interest in or responsibility for shaping and investing in improved national or city-level transport systems. This paper was prepared as a summary of the work of the New Climate Economy (NCE) and its partners on urban transport, updating this to include reference to the latest global evidence, an overview of international collaborative transport initiatives, and concluding with recommendations for policy-makers at the international, national and city levels. The paper reinforces the recommendations by The Global Commission on the Economy and Climate to encourage the move towards more compact, connected urban pathways.

The paper is largely based on the NCE cities papers prepared by LSE Cities (Floater et al., 2014a and 2014b; Rode et al., 2014; and Litman, 2015), CCCEP (Gouldson et al., 2015), and other recent NCE outputs, including the 2014 and 2015 reports of The Global Commission on the Economy and Climate.¹ The note was put together by Xiao Zhao, Anjali Mahendra, Nick Godfrey, Holger Dalkmann, Philipp Rode and Graham Floater. The authors wish to thank Thymen Kouwenaar, Henrik Gudmundsson, Michael Replogle and Helen Mountford, who provided valuable reviews of an earlier draft. The findings and conclusions in the paper do not necessarily reflect the positions or policies of the New Climate Economy or its partner institutes. This material has been funded by the Netherlands government.

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New Climate Economy
c/o World Resources Institute
10 G St NE
Suite 800
Washington, DC 20002, USA
+1 (202) 729-7600

New Climate Economy
c/o Overseas Development Institute
203 Blackfriars Road
London, SE1 8NJ, UK
+44 (0) 20 7922 0300

www.newclimateeconomy.report
www.newclimateeconomy.net



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Although more dispersed urban development is inevitable in some rapidly growing regions of the world, the benefits of this form of development are unclear and/or represent economic transfers that can reinforce existing social inequalities. Urban sprawl is one of the world's most significant market failures. While a degree of urban expansion is inevitable, particularly in emerging cities, urban expansion often goes far beyond what is economically efficient. A better understanding by national governments of the net costs of the current model of urban development could help them to identify more optimal urban expansion pathways.

The work of NCE demonstrates that countries and cities can follow a different growth pathway to unlock a new wave of urban productivity and transport connectivity based on more Compact urban growth, Connected infrastructure and Coordinated governance (the “3C” model). Encouraging this kind of compact and transit-oriented urban development is ultimately about harnessing the growth potential of cities, by reinforcing their central function: facilitating access to people, goods and services, and ideas.

This alternative growth pathway could bring a wide range of economic and social benefits including higher economic productivity, cost savings in transport and infrastructure investment, various health benefits, and reductions in carbon emissions. New work by NCE demonstrates that investments in public transport and non-motorised forms of travel could unlock an economic opportunity worth close to US\$11 trillion by 2050, based on energy savings alone. Analysis by NCE also suggests that savings of more than US\$3 trillion in infrastructure investment could be achieved by encouraging more compact, connected urban development over the next 15 years. Compact, better connected urban settlements with world-class public and non-motorised forms of transport are ultimately more productive, socially inclusive, cleaner, quieter, safer and lower-carbon.

Case study evidence suggests that we are already seeing tipping points towards more compact, connected and coordinated urban pathways. Bike-sharing schemes and bus rapid transit systems are both widely adopted around the world: 850 cities now have bike-sharing schemes with more than a million bicycles, and 198 cities have bus rapid transit (BRT) systems carrying close to 33 million passengers every day. Enhanced by information and communication technology (ICT), ride-sharing and ride-pooling services are growing exponentially and are already becoming part of the urban mobility ecosystem in many cities.

Although technological advances and innovations are available to support the scaling up of transformed urban mobility systems, countries and cities face significant barriers to action. These include weak fiscal bases for investment, fossil fuel subsidies, vested interests and consumer preferences towards private vehicle travel, and a range of institutional and governance barriers. Countries and cities at different stages of the urban transition and with different governance systems face very different barriers, and will require tailored strategies and policy instruments to achieve more compact, connected urban growth. The good news is that practical lessons have been learnt across many countries, which can inform future action, and while there may be losers in the transition, the net benefits are likely to significantly outweigh the costs, providing strong potential for relevant transition mechanisms and building political momentum for reform.

International cooperation can amplify and accelerate transformed urban mobility systems by developing common platforms for action, knowledge-sharing and capacity-building, and by enhancing cities' access to finance for sustainable transport. Noteworthy international initiatives in the transport sector, such as the Paris Process on Mobility and Climate and the International Association of Public Transport's Declaration on Climate Leadership, have already emerged to play an important role in supporting local, regional, national and global action on the economy and climate, although there remain challenges in ensuring adequate financial support and accountability for delivery.

To facilitate the global urban transport transition, it is recommended that national and city-level decision-makers consider setting up integrated transport and land use authorities to plan more connected urban growth, eliminate incentives to fossil-fuelled vehicle use, introduce new mechanisms to finance upfront investments in smarter urban infrastructure, and demonstrate leadership by committing to ambitious emission reduction targets and/or low-emission development strategies, with cities worldwide aiming to comply with the framework of the Compact of Mayors by 2020.

The international community, working with national governments and cities should help to accelerate and scale up these efforts by, for example, providing enhanced platforms for knowledge-sharing and technology transfer among cities through city networks such as the C40 Cities Climate Leadership Group and ICLEI (Local Governments for Sustainability), making a stronger political commitment to sustainable transport (including taking steps to strengthen existing international collaborative initiatives), and ensuring that investments are redirected towards supporting sustainable urban transport systems. The Partnership on Sustainable Low Carbon Transport (SLoCaT), the largest global initiative to push for sustainable transport, works with over 90 organisations to promote the integration of sustainable transport into global policies on sustainable development and climate change.

1. Introduction

Sustainable transport systems are crucial for underpinning the economic performance and prosperity of nations. They are also critical for tackling global climate change and reducing local air pollution. This is particularly the case in the world's urban areas.

The majority of transport trips take place in and between cities. Cities are growing at an unprecedented rate, particularly in the developing world: 1.4 million people are being added to urban areas each week, and by 2030, around 60% of the global population will live in cities.² Cities are engines of economic growth and social change, with urban areas accounting for about 85% of global GDP.

The current shape of urban development contributes to the growth and use of private motorised transport. There are over 1.2 billion motorised vehicles in the world today, and the number is expected to double by 2030. Accounting for 23% of the global energy-related greenhouse gas (GHG) emissions in 2010, transport emissions could double by 2050, and are expected to increase more rapidly than any other energy end-use sector.³ The transport sector is also a major source of air pollutants, such as black carbon and nitrogen oxide.⁴ Emissions and air pollution from the transport sector are often concentrated in urban areas: urban travel currently constitutes more than 60% of all kilometres travelled globally, and this looks set to grow in the future.⁵ As a result, urban transport is currently the largest single source of global transport-related carbon emissions and the largest local source of urban air pollution. The economic and wider prosperity of cities, and hence countries, is therefore inextricably tied to the development of efficient transport systems and the interface with the spatial pattern of urban development.

Despite the positive contribution of cities, the work of the New Climate Economy (NCE) has shown that, in many countries and major regions, the most common pathway of urban development remains characterised by unplanned urban sprawl and inter-city and intra-city transport networks dominated by conventional motorisation. This creates a wide range of economic, social and environmental costs, which can significantly constrain improvements in quality of life. For example, the total social cost of Beijing's dependence on motorised transport, including congestion and air pollution, is estimated at 7.5–15.0% of GDP.⁶ In the United States alone, work by NCE demonstrates that urban sprawl costs over US\$1 trillion per annum, including US\$400 billion in costs to the public purse and more than US\$600 billion in costs related to private vehicle use.⁷

Given the long-lived nature of urban infrastructure investments and the rapidity of change, this underscores the importance of acting now to set the world's urban future on the right pathway. Getting inter-city and intra-city transport systems right – and incorporating them as part of an integrated urban development strategy – will be a critical part of reimagining this future.

This paper provides an overview of the available evidence on the link between the effectiveness of transport systems and economic, social and environmental performance. It starts with a short overview of the main trends in urban transport in section 2, and then covers the costs of the current model of urban development and transport use (Section 3) and the benefits of an alternative model (Section 4).⁸ It discusses potential tipping points in transport mobility worldwide (Section 5) and barriers to scaling up positive change (Section 6). It concludes with an overview of international collaborative initiatives on urban transport in Section 7 and with some recommendations for policy-makers in Section 8.

2. The current model of urban development and transport use: key trends⁹

Economic development across much of the world is characterised by unmanaged urban sprawl and conventional, motorised transportation, in both developed and developing countries. The global urbanised land area almost tripled from 1950 to 2000, doubling in countries in the Organisation for Economic Co-operation and Development (OECD) and almost quintupling in non-OECD countries.¹⁰ If this pattern of urban growth continues, it is estimated that the total area of urban land will triple again from 2000 to 2030,¹¹ equivalent to an area the size of Manhattan being added every single day.¹²

This rapid urban expansion is being accompanied by, and promotes, fast growth of motorised vehicles, particularly in emerging economies. The total number of registered motorised vehicles exceeded 1 billion in 2010 (with more than 700 million cars and over 300 million trucks and buses, excluding two-wheelers), up from just 130 million in 1960.¹³ The number of motorised vehicles in the world has increased by 20% since 2010 alone, reaching 1.2 billion today,¹⁴ and is expected to double by 2030.¹⁵ In addition to this, the number of motorised two-wheelers is increasing even faster than the growth of cars in developing countries.¹⁶ A continuation of this pattern of development is likely to contribute to an increase of 80–100% in global energy consumption and GHG emissions from the transport sector alone by 2050.¹⁷

Urban form and transport connectivity

The spatial form of urban development and transport connectivity are closely inter-related: urban form and density has a profound influence on travel, while on the other hand, urban transport is an important factor in shaping urban form.

Urban sprawl is associated with lower densities and encourages urban activities to take place further apart from each other. Urban dwellers in sprawling cities need motorised vehicles to reduce their journey times and improve convenient access to goods, services and other economic opportunities, otherwise they would be forced to walk long distances. Coupled with affordable car ownership and fuel subsidies in some countries, lower densities contribute to the increased uses of private motorised vehicles and higher vehicle kilometres travelled (VKT) per capita.¹⁸ In contrast, cities with more compact design and greater infrastructure investment in non-motorised transport (NMT) and public transport promote their urban dwellers to use or shift to more sustainable transport modes, as they are more cost-effective and less time-consuming choices.

Looking in the other direction, transport systems also have a significant impact on urban form. Most notably, the affordability of private motorised vehicles – often related to the government subsidisation of fossil fuels and the lack of externality charges – encourages travel across relatively long distances within cities or to other cities, and thus accelerates outward expansion. Car-oriented transport systems also require vast space for parking, which reduces the available and valuable land area and space for other economic activities in city centres. In Los Angeles central business district, the parking area (including large multi-storey parking garages) equals 81% of the total land area.¹⁹ Extensive road infrastructure, a key feature for a car-oriented transport system, also contributes to urban sprawl and de-densification. In the United States, for example, one study estimates that the number of residents in central urban areas declines by 18% for each highway built through the urban core.²⁰ Similarly in China, another study estimates that 25% of residents in urban cores relocate to outer areas as a result of radial highways and ring roads.²¹

The complex interaction between urban development and transport connectivity has led to a number of major global trends: declining urban densities, a reduction in the shares of non-motorised transport and public transport, and enormous growth in private vehicle use.

i. Declining urban densities

A recent study demonstrates that, of the 78 largest cities in the developed world, 85% had faster development in suburban areas than in their urban cores. Another study of 120 cities across the world showed that urban densities declined in 85% of developing-country cities (75 out of 88 cities) and in all developed-country cities (32 cities) between 1990 and 2000.²² With the rate of de-densification continuing as high as it is today, global urban densities are projected to decrease by another 26% by 2040.²³

Developing country cities are de-densifying at a faster rate than cities in the developed world.²⁴ For example, Mexico's urban area expansion is almost four times higher than its urban population growth.²⁵ More generally, urban land use per capita increased by 3.6% every year in developing-country cities, higher than the 2.9% in developed-country cities.²⁶

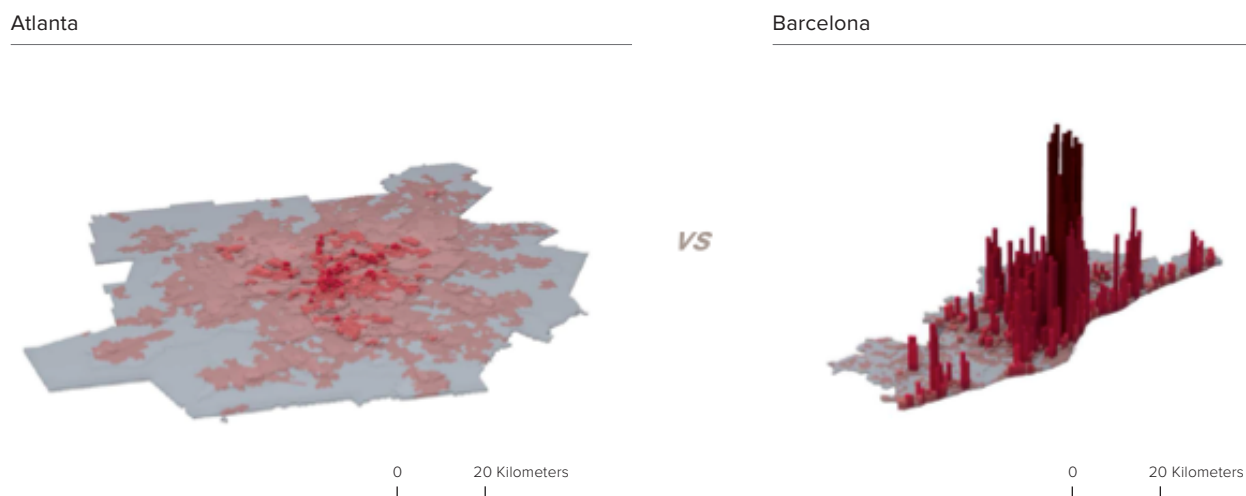
ii. A reduction in the shares of non-motorised transport and public transport

Non-motorised transport (NMT) mostly refers to walking and cycling. The modal share of NMT has been declining on a global basis,²⁷ although it is still the principal mode of transportation in most developing countries, particularly in Africa and Asia (driven by the absence of affordable and accessible alternatives for lower-income groups rather than high-quality infrastructure for NMT). For instance, the modal share of NMT is over 70% in Dakar, around 50% in some Chinese cities and more than 30% in most Indian cities.²⁸ However, the modal share is much lower in North American or Australian cities, where around 90% of trips are by motorised vehicle.

Despite this, in some European cities, the modal share of NMT is over 20%.²⁹ In some European countries, such as Netherlands and Germany, investments are channelled to improve infrastructure for walking and cycling, creating a safer and a more pedestrian/cyclist-friendly environment. This, together with more compact urban forms and lower car ownership, contributes to the relatively high NMT modal share in those cities.

Public transport is often seen as a key pillar of urban transport, but its modal share remains low on a global scale.³⁰ While local/national governments are struggling to finance the necessary investment in public transport infrastructure, subsidisation of fuel and parking space for cars provides further incentives for private vehicle use. This is particularly the case in developing countries where public transport infrastructure is often insufficient, inefficient and in poor condition.

Figure 1
Built-up area in Atlanta and Barcelona – Sprawling versus compact urban development



Source: Rode et al., 2014.³¹

Table 1
Features of sprawl and compact development

	Sprawl	Compact
Density	Lower-density, dispersed activities	Higher-density, clustered activities
Land use mix	Single use, segregated	Mixed
Transport	Automobile-oriented. Poorly suited for walking, cycling and public transport	Multi-modal. Encourages resource-efficient modes (walking, cycling and public transport)
Connectivity	Poorly connected roadway network	Highly connected roads, sidewalks and paths, allowing direct travel
Planning process	Unplanned, with little coordination between jurisdictions and stakeholders	Planned and coordinated between jurisdictions and stakeholders
Public space	Emphasis on private realms	Emphasis on public realms

Source: Litman, T., 2015.³²

In developed countries, the modal share of public transport differs significantly between regions and individual cities. It accounts for around 50% in some Asian and European cities such as Singapore and London,³³ but remains marginal (less than 10%³⁴) in cities in North America.

In many developing countries, informal transport (paratransit) – small, low-performance and often polluting vehicles – makes up for the absence of affordable and accessible public transport, and is one of the few modes of motorised transportation

available to the majority of people in cities. In some developing countries, paratransit can account for more than half of all motorised trips.³⁵ For instance, Nairobi's informal transport accounts for three-quarters of public transport trips and 36% of total traffic.³⁶ The modal share of informal transport in developing countries appears to decline as cities become wealthier and invest in formal public transport. In many Asian countries, cheap two-wheelers also account for a significant proportion of trips as people begin to rely on some form of motorised travel to cover the increasing distances in sprawling cities. The use of two-wheelers further diminishes the mode shares of public transport in these cities.

iii. Enormous growth in private vehicle use

Over the last few decades, the confluence of sprawled urban growth and declining shares of non-motorised transport and public transport has coincided with the enormous growth in private vehicle travels, first in developed countries and now in emerging economies. Most developed country cities, particularly in North America and Australia, continue to show significant dependence on private motorisation, with often more than 90% of trips by motorised vehicle – signifying a lock-in to a car-oriented pathway.³⁷

The trend in developing countries, particularly in Asia, is increasingly towards motorisation (both cars and motorised two- or three-wheelers). Although car ownership is significantly lower than it is in the developed world, the rate of growth is much faster. China, for example, added 17 million new cars in 2014, a 12.5% increase from 2013.³⁸ This can be partially attributed to rising incomes and a growing middle class in emerging economies, among other factors including fuel subsidies and the absence of externality charges. As a cheaper alternative to cars, the growth of motorised two- or three-wheelers is even higher in some Indian cities.³⁹ It is estimated that 114 million motorised two- or three-wheelers were sold in 2013,⁴⁰ and it is projected that the total number will reach 850 million by 2050.⁴¹

Motorised freight transport in urban areas, predominantly through diesel trucks, is increasingly frequent, often accounting for 10–15% of the VKT travelled in urban areas.⁴² Port cities, distribution centres and transport hubs in developing-country cities, like Shanghai and Mexico City, have a particularly high level of motorised urban freight distribution, and in cities in the least developed countries, less advanced modes of freight transport, such as motorised two- or three-wheelers or non-motorised carriers, are common and active. For example, motorised three-wheeled vehicles handle 60% of intra-city freight in Delhi.⁴³

3. Costs of business-as-usual urban development and transport use⁴⁴

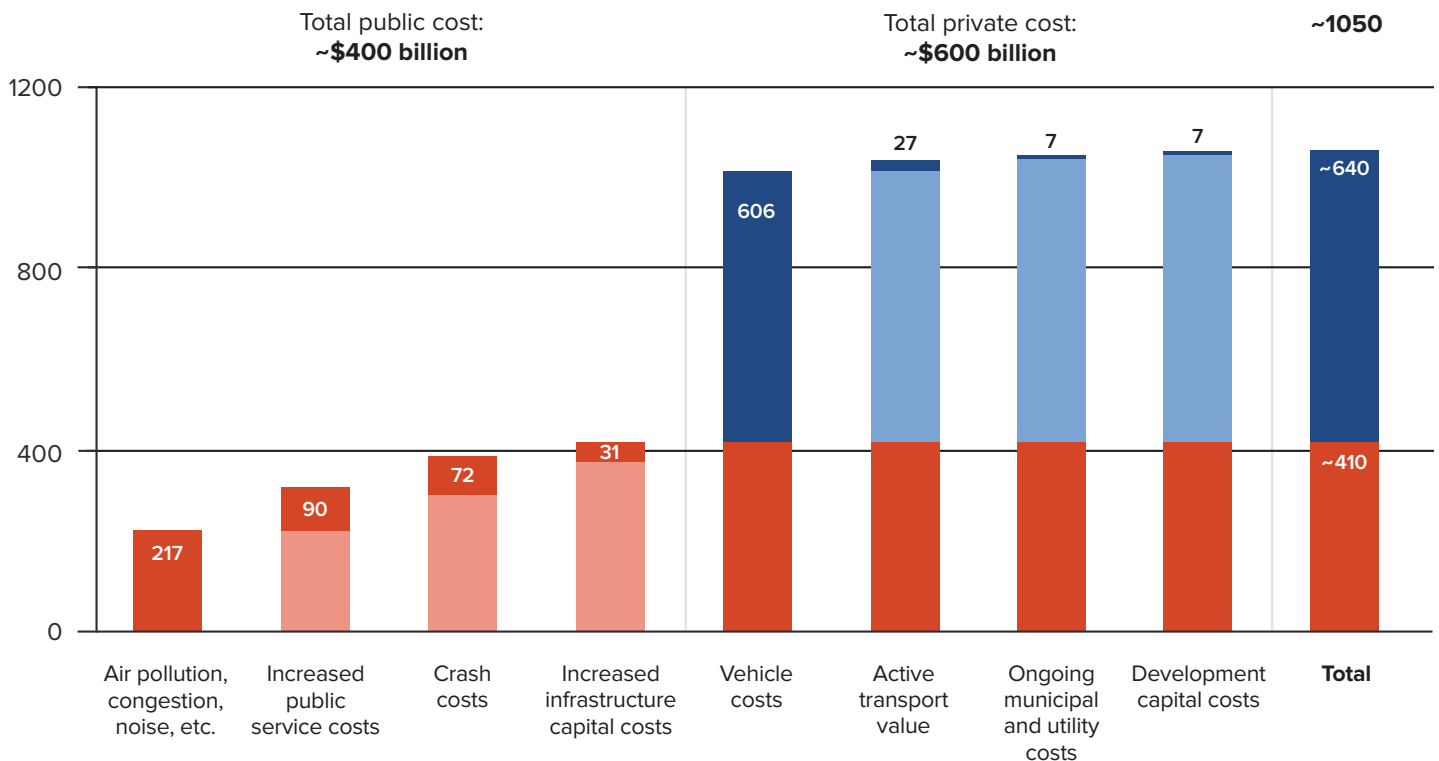
The business-as-usual pattern of urbanisation and transport mobility outlined in the previous section is imposing a range of significant economic and social costs. These include high infrastructure and operation costs, costs relating to traffic congestion and inefficient energy use, costs in terms of health and social exclusion, and a high carbon and environmental footprint.

High infrastructure and operation costs

The model of urban sprawl and conventional motorisation requires vast investment; as a result, there is often a funding gap and many cities fail to deliver basic urban infrastructure and services. It is estimated that aggregate urban infrastructure investment needs will amount to as much as US\$65 trillion by 2030,⁴⁵ including investment in transportation, water, housing and other social amenities. The construction, upgrade, operation and maintenance of roads and bus rapid transit (BRT) systems will require nearly US\$110 trillion in cumulative investment by 2050.⁴⁶ However, there's a huge investment gap, particularly in emerging economies where the urban infrastructure deficit is projected to be over US\$6 trillion by 2030.⁴⁷ India's gap in urban infrastructure investment is projected to be around US\$827 billion over the next 20 years alone, of which two-thirds is for urban road and traffic support.⁴⁸

More sprawling, disconnected urban development increases urban infrastructure investment requirements as infrastructure and public service provision needs to be extended into peripheral areas, leading to a significant reduction in available resources for core infrastructure, basic services and public transport. For example, in the United States, a study for NCE estimated that urban sprawl costs the US economy over US\$1 trillion per annum, greater than 5% of GDP in 2014. This includes over US\$100 billion in public costs relating to increased infrastructure and service delivery, and over US\$600 billion in private costs relating to private vehicle use, with the remaining US\$300 billion related to the costs of air pollution, congestion and traffic accidents (see Figure 2). If the United States followed an alternative growth pattern without urban sprawl, the savings could cover the country's entire funding gap in infrastructure investment.

Figure 2
Sprawl costs in the United States



Source: Litman, 2014. *Analysis of Public Policies That Unintentionally Encourage and Subsidize Urban Sprawl*.⁴⁹

Costs related to traffic congestion

Traffic congestion is common and increasingly acute with poor urban planning, limited road capacity, the absence of pricing mechanisms and the increasing number of motorised vehicles all being contributing factors to worsening traffic congestion levels, particularly in developing and emerging economies. Traffic congestion imposes huge economic costs, mostly related to time and fuel wasted and air pollutants emitted. In the United States, commuters lose 7 billion hours and 3 billion gallons of fuel in traffic congestion each year, equivalent to US\$160 billion of lost economic productivity.⁵⁰ In New York City, the time lost directly from traffic congestion cost an estimated US\$13 billion per annum, leading to a loss of 52,000 jobs annually.⁵¹ The costs related to congestion are also high in Europe and Asia. It is estimated that time loss from congestion incurs around 2% of GDP in Europe, and 2–5% in Asia,⁵² although the cost of congestion can be as high as around 10% in cities of emerging economies, such as Beijing and San Paulo.⁵³

Health costs

Increased levels of motorisation have negative health impacts, including health concerns related to air pollution, injuries and fatalities from road accidents, and reduced physical activity.

Urban air pollution on a global basis is very severe, particularly in emerging economies and developing countries, and is worsening with increasing motorisation. Analysis for NCE, covering 311 cities and close to a billion people, shows that the business-as-usual pattern of urban development is responsible for 86% of these cities exceeding World Health Organization (WHO) air quality guidelines for outdoor air pollution.⁵⁴ In 2012, 3.7 million premature deaths were related to outdoor air pollution,⁵⁵ and up to 75% of urban air pollutants are from fuel combustion in motorised vehicles.⁵⁶ It is projected that urban air pollution will be the principal environmental cause of premature deaths by 2050.⁵⁷ In terms of economic costs, it is estimated that health costs associated with air pollution in urban areas are approximately 5% of GDP in developing countries,⁵⁸ and exceed 10% of GDP in China.⁵⁹ In OECD countries, road transport accounted for about half of the total estimated cost of outdoor air pollution in 2010, or close to US\$1 trillion.⁶⁰

For pedestrians and cyclists, the risks of road accidents are high if there is a lack of well-designed NMT infrastructure, which is common in less developed countries. Road accidents cause injuries or even fatalities. Roughly 3,400 people die every day due to traffic crashes,⁶¹ with more than half in urban areas;⁶² almost half (49%) of those fatal accidents happen to pedestrians, cyclists and motorcyclists, who are the most vulnerable groups in road transport. Low- and middle-income countries account for 90% of the world's road traffic deaths, although they only account for half of the world's vehicles.⁶³ The economic cost associated with the road traffic fatalities and injuries is estimated at around 3% of global GDP, and up to 5% of GDP in developing countries.⁶⁴ Urban road accidents alone in developing-country cities can cost as much as 2% of GDP.⁶⁵

Another negative health impact of increased motorisation is the reduction in physical activity levels. Sprawled cities make services and economic activities segregated and further apart; and increased motorisation reduces walking or cycling due to safety concerns, particularly in NMT-unfriendly environments. This leads to decreased physical activity level for urban dwellers. There is increasingly clear evidence that physical inactivity increases the risks of some non-communicable diseases, such as diabetes, heart disease, stroke and colon cancer.⁶⁶

Inefficient energy use

Urban sprawl and motorised transport is associated with high energy consumption, including wasted energy in transmission, fuel for longer trips, and the energy required for extended infrastructure. In a study of 50 cities, it is estimated that almost 60% of the increase in estimated energy consumption is directly connected to excessive urban expansion, even more than the energy consumption related to GDP growth.⁶⁷ Cars are particularly inefficient users of energy: less than 1% of energy is actually used to move the passengers and transport them to their destinations. Around 86% of fuel is wasted in idling, engine losses and transmission losses.⁶⁸

Social exclusion

Sprawling and car-oriented transport systems contribute to greater income disparity and rising inequality. Poorer groups often live on the fringes of cities where transport systems are the weakest. It costs them more, in terms of both time and money, to get around. In the United States, for example, poorer groups spend twice as much as the others to get to work, in terms of percentage of household income.⁶⁹ In developing countries, urban dwellers spend 8–16% of their household income on transport on average, but for poorer groups, it can be greater than 25%.⁷⁰

The urban poor are heavily reliant on NMT and (informal) public transport. In the absence or deficiency of public transport in sprawling cities, the urban poor experience the greatest impacts. Their limited choice of transport mode deprive them of accessibility to better education, jobs and opportunities. The poorest groups, who have no other choice than walking/cycling, are also the most vulnerable to road accidents and other negative externalities like air pollution. The combined effects of urban sprawl and motorisation are also linked to the growth of both slums and gated communities (for example, low-density luxury villas where public spaces are privatised), which are increasing the segregation between the rich and the poor and creating socially divided cities.⁷¹

High carbon and environmental footprint

The transport sector is responsible for 23% of global energy-related GHG emissions,⁷² and urban travel is the single largest source of emissions in the transport sector. With continuing urban sprawl and increased motorisation, energy consumptions on urban transport are projected to double by 2050.⁷³ Emissions from freight transport vehicles, predominantly (diesel) trucks, are a particular issue. They produce disproportionately more carbon emissions (up to 50%),⁷⁴ and are also a major source of particulate matter, black carbon and nitrogen oxide emissions.⁷⁵ In India, trucks account for only around 5% of vehicle fleet, but contribute to 74% of fuel use, 63% of CO₂ emissions, 59% of particulate matter emissions and 26% of road accidents.⁷⁶ In addition, building urban infrastructure requires concrete, steel and cement, with significant embedded energy and carbon emissions. Construction of infrastructure in developing countries under 'business as usual' is projected to emit around 470 billion tonnes of CO₂ by 2050, much of this in sprawling cities.⁷⁷

Perceived and real benefits of current model of urban development

It is important to acknowledge that there are benefits to the current model of urban development. For example, there is evidence to suggest that more sprawled models of urban development can increase housing affordability by allowing the development of inexpensive land on urban fringes. Recent evidence from the United States, which scores 221 US metropolitan areas and 994 counties to create a 'sprawl index' suggests a 10.0% increase in the sprawl index reduces the average household income spent on housing by 1.1%. However, the work also finds that this is often more than offset by increases in transportation costs, including residential parking costs and total transport expenses.⁷⁸

While contributing to lower land prices and the availability of larger houses with larger gardens and more privacy, dispersed development can also reduce the local intensity of impacts such as traffic congestion, air pollution and noise (measured per hectare of developed land). However, at the aggregate level, this is often offset by increased vehicle travel and increases in the total area developed, which increases noise and air pollution imposed on urban neighbourhoods.⁷⁹

In summary, sprawl can provide the following benefits:

- lower land prices (cost per hectare)
- more private green space (lawns and gardens) and privacy
- cheaper vehicle parking
- reduced local traffic congestion
- less exposure to some local pollutants and noise.

However, these benefits are mostly internal (directly accruing to the people who choose sprawled locations or private developers) and/or represent economic transfers (one group benefits at another's expense, for example when lower income groups benefit less than other groups from additional road infrastructure but are impacted by higher utility and public service costs). There is limited evidence to suggest that sprawled development provides extensive aggregate external benefits.

That said, it is important to acknowledge that a degree of urban expansion is inevitable, particularly in emerging cities, driven by a range of factors, including income and population growth, the falling costs of private vehicle travel, and reductions in the value of rural land as economies undergo structural transformation. However, urban expansion often goes far beyond what is economically efficient (that varies significantly depending on specific local conditions). As outlined in *Better Growth, Better Climate*, urban sprawl, defined here as the uncontrolled and excessive spatial expansion of cities, is one of the world's most significant – and least well documented – market failures.⁸⁰ Hence, a better understanding by national governments of the net costs of the current model of urban development could help countries and cities to identify more optimal urban expansion pathways, and then to plan urban development and transport connectivity accordingly.

4. A new model of urban development and transport connectivity

The work of NCE demonstrates that countries and cities can follow a different growth pathway to unlock a new wave of urban productivity and transport connectivity based on Compact urban growth, Connected infrastructure and Coordinated governance (or the so-called “3C” model of urban development).⁸¹

- **Compact** urban growth refers to managed expansion and/or urban retrofitting that encourages higher densities, contiguous development, functionally and socially mixed neighbourhoods, walkable and human-scale local urban environments, the redevelopment of existing brownfield sites and the provision of green spaces. Compact growth represents relatively dense, proximate development, with high levels of accessibility to local employment and services. This type of development is not about urban containment or solely about high density, but rather about how urban expansion is managed to limit unplanned peripheral development and build dense, transit-oriented urban forms. Density is a necessary but not sufficient condition for smarter urban development: land use mix, connectivity and accessibility are equally important.
- **Connected** infrastructure refers to investment in innovative urban infrastructure and technology, with a focus on smarter transport systems to connect and capture the economic benefits of more compact urban forms. These transport systems would connect mixed-use, employment, housing and commercial clusters. They include mass rapid transit (including subways, light rail systems and bus rapid transit systems), bicycle “superhighways”, car- and bicycle-sharing, smarter traffic information systems, and electric vehicles with charging point networks using renewable energy sources.
- **Coordinated** governance refers to effective and accountable institutions to support coordinated planning and implementation across the public and private sectors and civil society, particularly for land use and transport integration. The existence of organisations dedicated to coordinating policies within entire urban agglomerations, for example, has especially positive effects, ranging from lower levels of particulate matter air pollution to a reduction in urban sprawl.

Encouraging more compact, connected and coordinated cities is ultimately about harnessing cities’ growth potential by reinforcing their central function: facilitating access to people, goods and services, and ideas. Throughout history, cities have been dynamic centres of economic specialisation and cultural expression. By enabling the concentration of people and economic activities in a smaller geographic space, these economic and social interactions create a vibrant market and fertile environment for innovation in ideas, technologies and processes, spurring innovation and productivity.⁸²

More compact urban growth can significantly reduce the cost of providing services and transport infrastructure. It also significantly increases the viability of public transport and other urban infrastructure, by attracting more intensive use, and creates a deeper labour market that can achieve faster and better job matches. Moreover, the components of this system are self-reinforcing, generating a virtuous circle: more compact urban centres concentrate urban innovation and job creation, helping to attract talent and capital for investment in smarter transport infrastructure and technology, and widening the skilled labour pool.⁸³ The model can also lead to a wide range of co-benefits, such as reduced congestion, improved air quality, reduced carbon emissions and enhanced social inclusion.

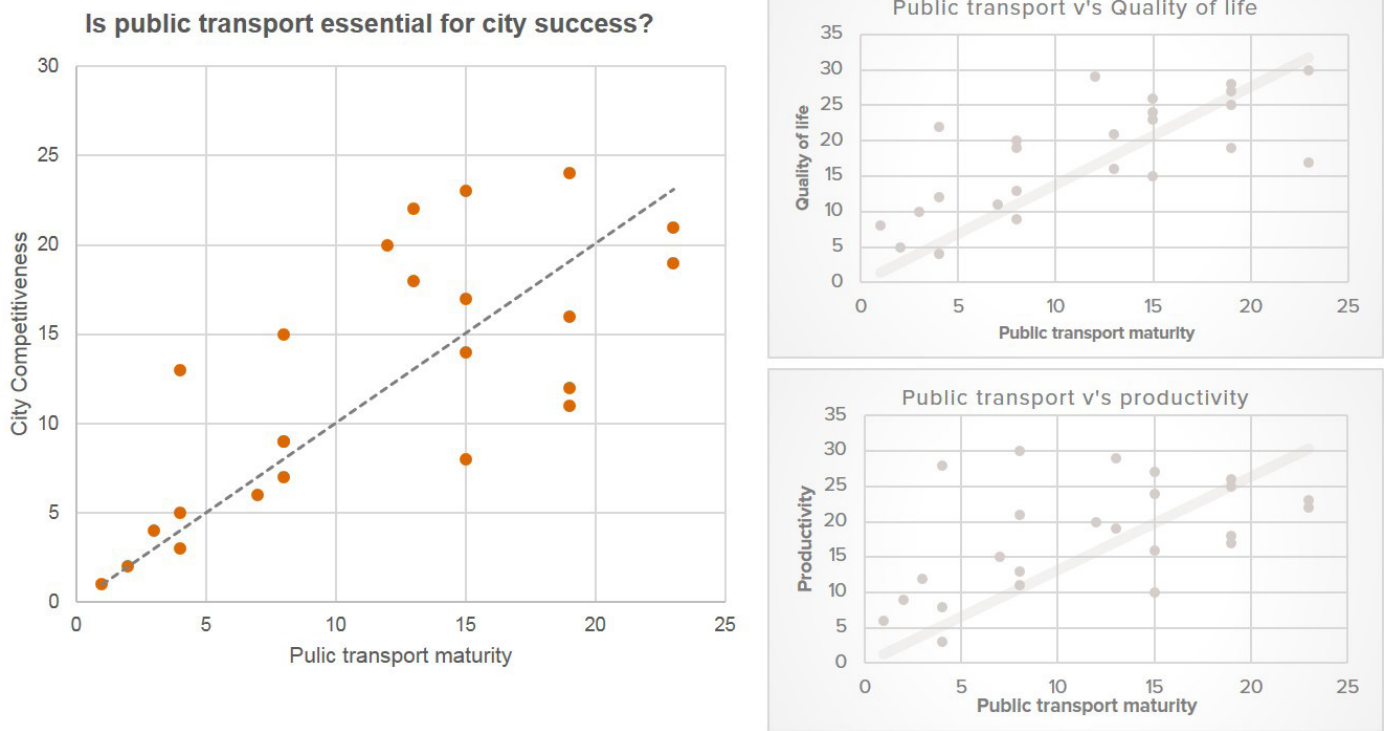
In the medium to long term, the economic and social benefits of a large-scale shift to a compact, connected and coordinated urban pathway include strengthening local economies, closing the infrastructure gap, savings on transport costs, benefits to health and social equity, reduction in carbon emissions, and making freight greener.

Strengthening local economies

On average, cities that are better connected by public transport not only achieve higher economic productivity, greater purchasing power and better quality of life, but also attract more direct investment.⁸⁴ (See Figure 3.) A more compact model of urban development increases the concentration of people and economic activities, and thus promotes economic, business and social interactions. This spurs productivity and innovation through agglomeration effects and knowledge spillovers. A recent study of China, for example, demonstrates that more compact, connected urban development could help to accelerate economic growth and productivity, and encourage a larger share of tertiary industry by 2030.⁸⁵ A study from New Zealand demonstrates that doubling urban densities could enhance productivity by 6–7%.⁸⁶

Figure 3

Correlation between public transport and city competitiveness, quality of life and productivity



Source: PwC, 2014.⁸⁷

More compact, transit-oriented cities can boost GDP and create attractive jobs. One study of the macroeconomic effects of related policy measures in Germany shows that measures to promote walking and cycling could boost GDP by 1.11% and increase total employment and employment in the transport sector by 1.37% and 4.14% by 2030; and measures to improve public transport could have even larger impacts – expanding GDP by 1.56% and increasing total employment and transport employment by 1.76% and 5.29% respectively by 2030.⁸⁸

Although there may be potential job losses in those countries that are particularly dependent on the automotive industry, which will require transitional mechanisms, additional transport sector jobs can be generated through sustainable transport infrastructure investment, including construction, maintenance and operation of public transport systems. For example, in the United States, spending US\$1 billion on public transport per annum can support 36,000 jobs on average. This is 9% and 19% higher than the number of potential jobs created in road maintenance or new road projects respectively (on the same amount of resources). These jobs have the potential to boost GDP by US\$1.8 billion.⁸⁹

In developing countries, where the last mile of journey is highly dependent on informal transport, public transport systems could better integrate the informal transport sector. In some cases, this could also create more reliable employment and livelihoods for the informal suppliers of small and low-performance vehicles, while improving operational efficiency and improving service quality for kilometre. For example, in Mumbai and New Delhi, there are designated spaces for informal rickshaws to park and line up for customers at stations; and in the city of Ahmedabad in India, the G-Auto rickshaw service, designed like a dial-a-ride taxi service, is proving to be very successful.⁹⁰

Closing the infrastructure gap

More compact, transit-orientated models of urban development can significantly reduce infrastructure spending. Analysis by NCE suggests that savings of more than US\$3 trillion in infrastructure investment could be achieved over the next 15 years alone.⁹¹ New analysis by the World Bank suggests that China could save up to US\$1.4 trillion in infrastructure spending,

equivalent to 15% of its GDP in 2013, by pursuing a more compact and transit-oriented urban development model.⁹² This could help China to close its investment gap of approximately US\$160 billion.⁹³ In addition, a study for NCE shows that the United States could save an estimated US\$200 billion annually through savings in infrastructure investment and provision of services by encouraging smarter urban growth (see Figure 2).⁹⁴

Cost saving in the transport sector

Compact and transit-oriented cities facilitate passengers to shift toward NMT and public transport modes, and enhance transit efficiency. This leads to potential reductions in spending on fuels and transport. NCE’s 2015 report *Seizing the Global Opportunity* shows that investments in the urban transport sector that promote a shift towards public transport and non-motorised forms of travel could unlock an economic opportunity worth close to US\$11 trillion by 2050, based on energy savings alone.⁹⁵ Some estimates suggest that spending on transport accounts for 4% of GDP in Copenhagen, whereas spending in car-oriented Houston is around 14%.⁹⁶ In New York City, transport savings related to density are estimated at around US\$19 billion per year.⁹⁷ More transit-oriented urban settings in the United States could reduce per capita car use by 50%, and household expenditure by 20%.⁹⁸

Looking at infrastructure investment in the transport sector only, analysis by the International Energy Agency (IEA) suggests that if countries pursue “avoid and shift” policies⁹⁹ consistent with a 2°C scenario, this could unlock close to US\$20 trillion in savings in global land transport infrastructure spending by 2050.¹⁰⁰ (See Table 2 below).

Table 2
Global land transport infrastructure investment requirement by 2050

	Infrastructure expenditures (billions US\$)	
	4°C scenario	2°C scenario with “avoid, shift and improve” approach
Road	75,400	61,100
Bus rapid transit	48	406
Parking	33,600	24,000
Rail	7,800	9,300
High-speed rail	1,400	4,100
Total	118,200	98,200

Source: IEA, 2013.¹⁰¹

Health benefits

Shifting passengers to more sustainable transport modes, such as public transport, walking and cycling, can improve air quality. For example, after Beijing restricted the number of cars on the road in 2008, the concentration of PM2.5 fell by 31%, and asthma-related doctor visits reduced by 50%.¹⁰² Ho Chi Minh City also achieved a 44% reduction in PM2.5 and 27% reduction in CO₂ emissions as a result of more compact urban growth.¹⁰³ In the UK, the benefits associated with walking and cycling, in economic terms, are around £17 billion per year.¹⁰⁴ The net social gain of cycling is about US\$0.21 per cycled kilometre, mostly from savings from health care.¹⁰⁵ More compact urban form makes it easier and more convenient for people to travel by public transport, reducing road accidents and fatalities. New York’s traffic-fatality rate is only one-third of the rate of the more sprawling Atlanta.¹⁰⁶

Social equity

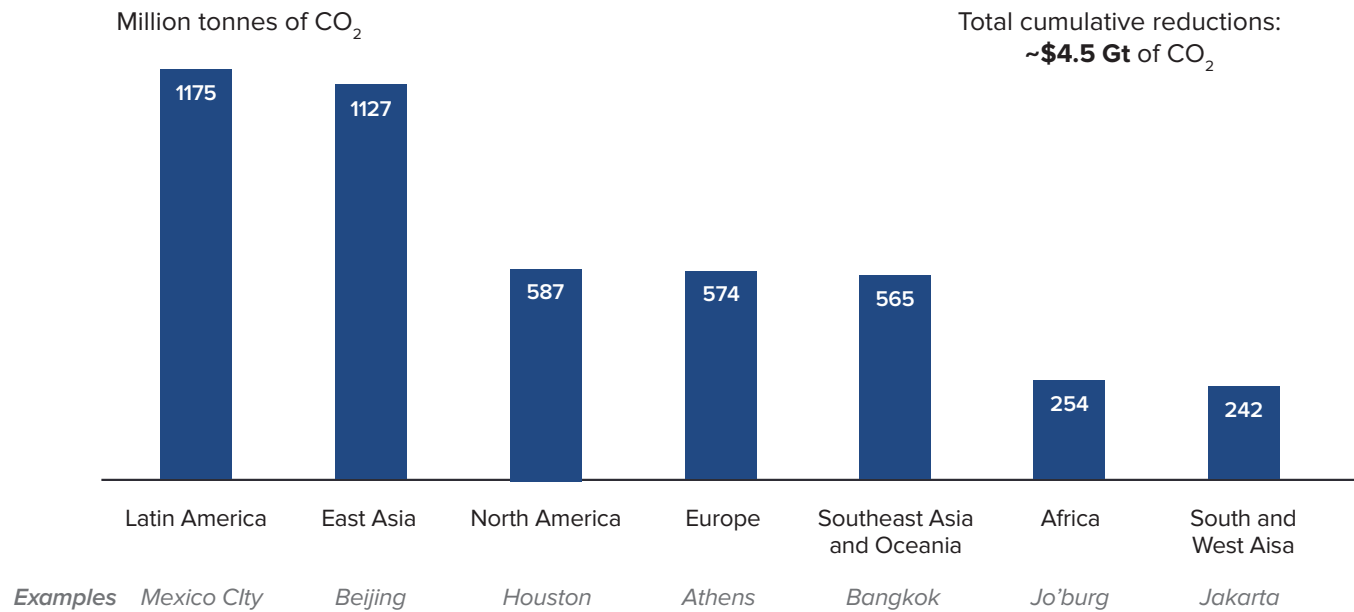
The benefits of affordable and accessible public transport have disproportionately positive impacts on the urban poor. Transport systems in compact urban settings enable the poorer group to access jobs, education and economic opportunities with less costs on transport.¹⁰⁷ For example, lower-income households in compact urban settings in Brazil only spend 10% of their income on transport, which is much below the average in Brazil.¹⁰⁸ In addition, the construction and maintenance of NMT and public transport infrastructure can provide employment opportunities as stated earlier.

Carbon emissions reduction

The potential to reduce carbon emissions is a co-benefit to most of the benefits discussed above. On a global level, compact urban form and sustainable transport systems and infrastructure could reduce GHG intensities by 20–50% in the medium- to long-term based on 2010 a level.¹⁰⁹ Urban transport emissions could be reduced by 35% worldwide by 2030, equivalent to saving 1.4 Gt CO₂ every year.¹¹⁰ Radical shifts in transport modes in C40 cities alone, including Mexico City, Beijing and Houston, could provide a reduction of 4.5 Gt CO₂ by 2030.

Figure 4
Emissions reduction potential in C40 cities by region

Potential cumulative reductions in carbon emissions from reducing car ownership levels to those of leading benchmark cities in region, 2012-2030



Source: NCE analysis (2014).¹¹¹

Greening freight

Freight distribution in more compact and denser cities is likely to have lower vehicle meters travelled (VMT) per capita. A study of the largest 10 metropolitan areas in the United States shows that truck VMT per capita tends to reduce as the population increases, and higher densities could promote shorter freight distribution trips and lower truck VMT per capita.¹¹² On the contrary, logistical sprawl tends to generate additional VMT and CO₂ emissions in urban areas. For example, following the spatial de-concentration of logistics facilities in Paris metropolitan areas over time, it takes more truck-kilometres to reach urban destinations to and from terminals, and also generates more CO₂ emissions.¹¹³

Compact urban setting may create some challenges for freight distribution due to congestion, noise and air pollution caused by trucks and increased likelihood of conflicts between trucks and other commuters on road. However, the evidence suggests that these challenges can be managed through the adoption of self-contained freight villages, and use of smaller and greener vehicles for the last mile distribution within a city centre. Regulation or pricing mechanisms, such as restricting time periods for goods delivery to off-peak hours and having lower pricing in off-peak hours, can also be implemented to address those challenges.

While the general concept and approach of the “3C” model is relevant for cities at all stages of urban development, cities with different economic, geographical and cultural contexts should explore and pursue more tailored policies and measures to shift towards more compact, connected and coordinated urban development.¹¹⁴ For example, emerging cities and small urban areas can leapfrog to more sustainable urban development by designing and building compact city policies and features from the start. Megacities can build strong institutional capacity and unified public transport authorities to achieve vibrant and world-class transit systems, and re-densification as a by-product. Mature cities that may have locked in to sprawling could concentrate resources in transit development in denser areas.

Addressing limitations to compact urban growth

In addition to its benefits, it is important to acknowledge the potential limitations and drawbacks of compact urban growth; for example, the most common criticism is that urban containment will drive up house prices. These lines of argument and the evidence are comprehensively investigated in a recent contribution for NCE.¹¹⁵ While the evidence suggests that tight restrictions on urban expansion may increase land unit costs (per square metre), smart growth reduces other costs including land required per housing unit, residential parking requirements, infrastructure and utility costs, and household transport expenses. As a result, smart growth policies can increase affordability overall, particularly for lower-income urban residents who live in multi-family housing and rely on walking, cycling and public transit. Moreover, what this and other evidence demonstrates is that regulatory limits on the height and density of buildings in urban areas are often the culprit responsible for driving up house and property prices, which also deters compact urban development. For example, according to an LSE study, land use regulations in the West End of London inflate the price of office space by 800%.¹¹⁶

Table 3

Strategies to encourage more compact, connected, coordinated urban development in different urban types

Urban type	Strategic choices
Emerging cities	<ul style="list-style-type: none"> • Compact – Design in compact city features from the start, including integration of industrial and residential areas, and efficient public transport routes • Connected – Introduce surface-based public transport based on bus and BRT systems and rapid rail where appropriate, along with provision of infrastructure for non-motorised travel • Coordinated – Build capacity for integrated land use and transport planning
Megacities	<ul style="list-style-type: none"> • Compact – Re-densify through regeneration of existing city cores and multiple hubs, brownfield redevelopment, and urban retrofitting. Initiate well-managed growth of urban periphery • Connected – Further expand existing public transport systems and increase share of NMT and public transport • Coordinated – Integrate land use and transport planning with regulatory, fiscal and financial policy instruments across municipalities within the metropolitan area such as land-value capture and road pricing
Mature cities	<ul style="list-style-type: none"> • Compact – Re-densify through regeneration of existing city cores and supporting hubs, brownfield redevelopment, and urban retrofitting • Connected – Introducing NMT such as cycling infrastructure • Coordinated – Integrated land use and transport planning, including regulatory reform

Source: Floater et al., 2014.¹¹⁷

Some commentators also argue that per capita congestion costs are the highest in the densest urban regions; however, the densest urban regions they refer to tend to be larger cities, and congestion costs tend to increase with city size. Comparing cities of similar sizes, the evidence suggests that those cities that are more compact and transit-oriented, such as New York, have less congestion delay hours per commuter than the more sprawled cities such as Houston and Atlanta.¹¹⁸

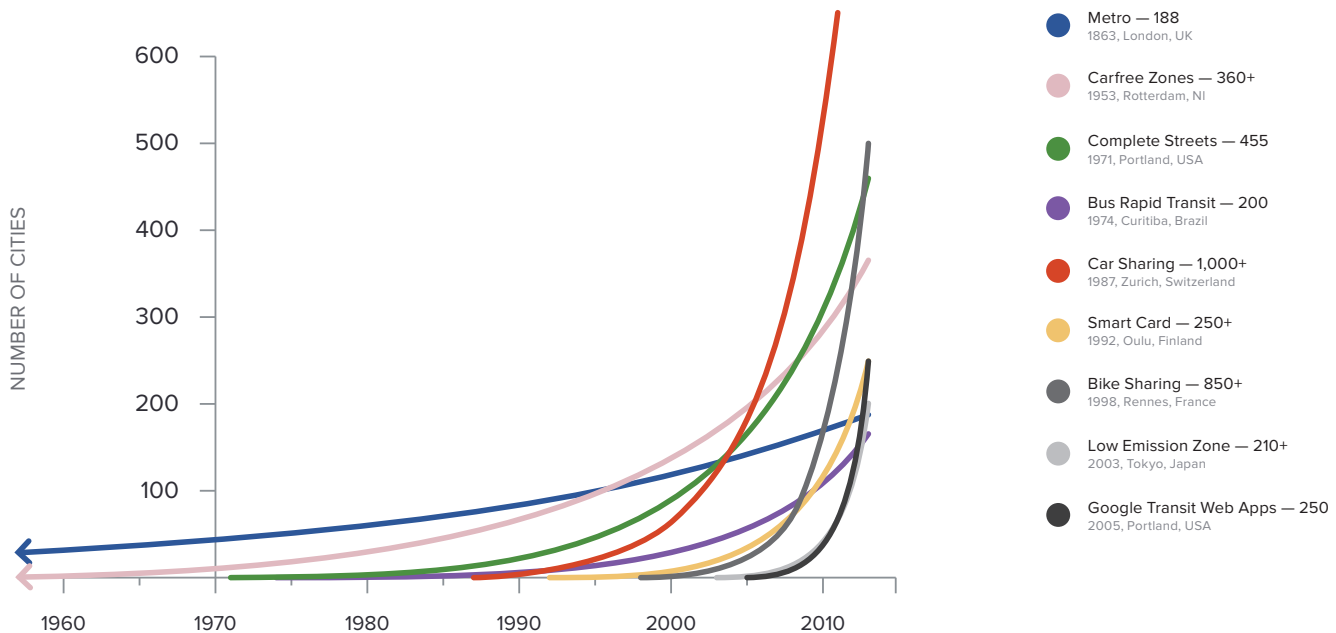
There is also a perception that compact urban development contradicts consumer preferences for single-family housing that provides more privacy and private green space. However, housing preferences are diverse and, in some countries, are rapidly changing. Although some surveys, for example, indicate that most North American households prefer single-family homes, they also value smart growth features such as convenient access to local services and shorter commutes, and many households would choose more compact housing options if given suitable incentives such as better schools or financial savings. Evidence suggests that, in most urban regions, smart growth can accommodate 35–70% single-family or adjacent (townhouse) housing.¹¹⁹ This kind of “good densification” not only addresses different preferences for housing, but can also be livable, cohesive and spacious.¹²⁰

Irrespective of the balance of evidence, it is important to be aware that efforts to contain the outward expansion of cities without taking into account projected population growth does run the risk that population growth will outpace housing provision, which can drive up housing prices and result in more people living in informal settlements. Therefore, it is important not to argue for strict urban containment but for intelligent policies and investments that manage uncontrolled, inefficient urban expansion, given its detrimental economic, social and environmental consequences.

5. Tipping points in urban transport connectivity

There is strong evidence that compact, better connected urban settlements with world-class public and non-motorised forms of transport are more productive, socially inclusive, cleaner, quieter, safer and lower carbon. However, there is less consensus on whether it is possible to develop cities in ways that arrest what some see as an inevitable expansion of existing patterns of urbanisation and the rise of private vehicle use. Case study evidence suggests, however, that we are already seeing tipping points towards more compact, connected and coordinated urban pathways.¹²¹

Figure 5
Tipping points in transport systems



Source: WRI EMBARQ.¹²²

Non-motorised transport

Car-free zones were first introduced in Rotterdam in 1953, and have now been adopted by over 360 cities, particularly cities in Europe.¹²³ It is increasingly popular for cities to open up car-free zones, more specifically pedestrian zones and bicycle lanes. Shanghai and Singapore have pedestrian zones, which are built with better lighting and more greenery. Some cities, such as Jakarta, are restricting car access to certain streets on weekends to promote walking or cycling. Cities like London and New York are dedicating more lanes for bicycles to make cycling easier and safer, and to reduce travelling time. Copenhagen has taken it to the next level – an elevated cycle highway at first ‘floor’ level, leaving pedestrian and motorised vehicles on the ground.

Bike-sharing schemes are also widely adopted. After Paris pioneered the bike-sharing scheme in 2010, 850 cities across the world have now built up bike-sharing schemes, with more than a million bicycles.¹²⁴

Public transport

Many cities worldwide are also expanding and improving mass rapid transit to improve urban mobility. In 1974, Curitiba piloted the bus rapid transit (BRT) system, a form of high-capacity urban transport with dedicated lanes, custom-designed bus stations and a smart ticketing system. To date, 198 cities have followed suit, carrying close to 33 million passengers per day.¹²⁵

BRT systems require relatively low capital investment, but generate a wide of range of economic, social and environmental benefits. For example, Johannesburg built the first BRT system in Africa, Rea Vaya. The direct economic returns from Phase 1A are approximately US\$143 million. If considering wider benefits, the economic returns are estimated to be almost US\$900 million.¹²⁶

Table 4

The economic benefits of the Rea Vaya BRT system

Components of economic benefit	Net present value (US\$ millions 2012)
Travel time savings	331
Improved road safety	268
Increased physical activity	141
Operating cost reduction	170
Travel time lost during construction	-38
CO ₂ emissions reduction	18
Total economic returns	892

Source: Carrigan et al., 2013.¹²⁷

Other cities have started to show trends related to declining car ownership in the pursuit of urban sustainability. For instance, New York, London and Berlin have all shown reductions in car ownerships over the last 10 years while at the same time experiencing positive expansions in their economies.¹²⁸

Transport demand management (TDM)

Congestion pricing was first implemented in Singapore in 1975. London, Stockholm and a few cities followed Singapore in adopting such schemes. Through congestion charging, London reduced vehicle traffic by 16% and journey times by 14% within the first three years of its implementation. This has also been estimated to extend life expectancy by 1.83 years for those living in congestion charging zones.¹²⁹

Vehicle quota systems started in Singapore in 1990. Some Chinese cities, such as Beijing, Shanghai and Shenzhen, are also implementing such schemes to ease congestion.

Information and communication technology (ICT) is also opening up possibilities for more efficient vehicle use and more accurate traffic information, optimising traffic flows. Real-time analytics and data on traffic conditions could help drivers to choose the most desirable route, i.e. the shortest distance trip with least congestion. Ride-sharing and car-sharing can also be enhanced by ICT.

On average, cars sit idle for most of the time (in the US, it's about 96% of time¹³⁰). Ride-sharing and ride-pooling services have been growing exponentially and already become part of the urban mobility ecosystem in many cities. Car-pooling services have the potential to reduce carbon emissions. Car-sharing, though less extensive than ride sharing, is also developing fast, particularly in developed-world cities.¹³¹ Both could offer an alternative to car ownership through increasing the utilisation rate of existing vehicles.

Mixed picture on electric vehicles (EV) and autonomous driving

EVs are currently more expensive than petroleum cars due to high battery costs. High infrastructure investments, particularly for charging stations, are also required. This is limiting current penetration into the automobile market – EVs still account for less than 1% of total car sales in the world, although in some countries with generous EV policies, such as Norway, EVs are among the best-sold cars and account for over a quarter of new car registration.¹³² The cost of EV battery packs continues to fall due to advances in battery technology, and it is projected that the annual sales of EVs and hybrids will increase to 11.5 million in 2022, accounting for about 11% of the global car market.¹³³ However, while EVs have the potential to increase energy efficiency and reduce emissions of air pollutants, they have limited impacts in easing congestion and reducing traffic accidents.

Autonomous driving is still in the testing stage, but it is estimated that it could reduce road accidents by up to 90%, saving up to US\$19-billion per annum in the United States.¹³³ However, autonomous driving could increase the overall volume of car travel,¹³⁴ despite the fact that it could increase carrying capacities in cars as a result of the empty driver's seat, and reduce neighbour time due to embedded ICT that allows cars to travel at the optimal speed.

Research and analysis are currently limited, so it is still an open question whether EVs and autonomous vehicles will transform mobility and it is unclear the extent to which they might continue to perpetuate a model of sprawled urban development with the associated economic, social and environmental costs outlined above.

Multi-modal

Some cities are also getting increasingly good at encouraging multi-modal integration, which seamlessly transfers passengers between different transport modes, particularly NMT and public transport. Real time information and cost-efficient trip planning also allow passengers to travel more easily, and save spending in terms of both time and money. At the same time, smart and integrated ticketing systems offer more convenience and reduce travel times by enabling people to use one card to pay for metro, bus, bike-sharing, taxi and other forms of transport modes.

European countries, such as the UK and Netherlands, are taking the lead in enhancing urban inter-modality through infrastructure, information and fare integration. In London, more than 70% of people use their smart phones to get updates on traffic conditions, plan their journeys or top up their travel card.¹³⁵ Helsinki is developing a programme that enables people to book and pay for all kinds of trips. The aim is to drive down the demand for private cars to zero by 2025.¹³⁶

The development of multi-modal integration is, however, quite limited in developing countries. It is challenging because there is heavy reliance on informal modes of transport, whose operations are not regulated. However, some cities, such as Mumbai and Ahmedabad, have successfully integrated access for auto-rickshaws at public transport stations through designated parking and waiting spaces.

Freight transport

In relation to the specific issue of energy efficiency in freight transport, this is currently very low, mostly due to low fuel quality of the trucks and a large portion of "empty miles". Energy efficiency technologies and practices are available, but not widely adopted by truck companies despite potential fuel savings and wide economic benefits. This is often because of the many existing regulations and taxes issued for truck companies, the lack of information and confidence in those technologies and practices among truck companies, and governments' limited attention, efforts and policies in addressing this issue.

In some countries and cities, night deliveries and off-peak deliveries have been adopted as they allow trucks to travel at a less congested time and reduce friction with other commuters. While carriers prefer such deliveries, retailers are reluctant to choose this option as they need to allocate labour for night hours, incurring additional costs.

Urban freight centres and local freight stations offer places for consolidation or deconsolidation for pick-ups and deliveries. These facilities impose higher costs and additional delays, although they lead to less congestion and less parking space required.

Modal adaptation for freight transport, particularly for “last-mile” vehicles, could be applied in more compact and denser urban settings. Using more energy-efficient and less polluting vehicles can reduce energy consumption, carbon emissions and air pollutions. However, the capacity of adapted vehicles, such as vans and bicycles, is relatively small.

There is therefore a role for national and local policy-makers in recognising the significance of freight distribution for the economic, social and environmental viability of urban areas. Policy-makers need to work with stakeholders, including truck operators and businesses, to agree a set of national and local climate- and environment-related targets, as well as regulation and pricing for freight vehicles that is harmonised with other economic, land use and transport policies. In Austria, Germany, the Netherlands and Switzerland, stringent regulations and pricing for freight vehicles have prompted the greening of freight vehicles and urban distribution systems, and the redesign of supply chains.

Emergence of city clusters and growth of inter-city transport

In many countries, cities are rapidly reaching out beyond jurisdictional boundaries through the formation of city clusters and large urban agglomerations. This can boost regional economic development, generate further employment opportunities, and lead a set of wider benefits through facilitating economic, social and cultural interactions between cities.

There are three principal forms of city clusters – city region, urban corridor and mega region.¹³⁷ City region is often a large city partnering up with nearby smaller cities and towns as the development of the large city spills over to its surrounding regional space. Such examples include city regions around Cairo, Mexico City and Bangalore. When there are two or more large cities, such as Delhi and Mumbai, Sao Paulo and Rio de Janeiro, they tend to form transport corridors to promote industrial development, business and trade. Mega regions, or “supra-agglomerations” are formed as part of national-level development strategies to promote regional development through better flow of goods and capitals. China has several mega regions, such as Pearl River Delta and Yangtze River Delta.

Connectivity and regional transport are crucial to facilitate the formation of city clusters and regional development. Based on geographical, economic and cultural features, city clusters across the world have significantly different patterns and transport systems, predominantly road, high-speed rail and multi-modal networks.

City clusters in the United States are built along its freeway systems, with specialised functions and dispersed settlements. The National Highway System, covering 260,000 kilometres, is strategically connected to major transport hubs and facilities – airports, railway stations and ports. It accounts for only 4% of national roads, but carries over 40% of highway traffic, 75% of heavy truck traffic and 90% of tourist traffic. About 90% of the population, including all urban populations, live within 8 kilometres of the network.¹³⁸ There is no doubt that the well-developed National Highway System is good for connectivity, but it also creates disincentives to the ridership of inter-city public transport. Investing in highways and road infrastructure has an opportunity cost of less investment available for public transport systems that are more sustainable.

However, in some countries, transformations in inter-city transport systems away from dependency on private vehicle travel are occurring. For example, Japan is pioneering high-speed rail for regional development and mobility. National government, local government and rail companies shared the cost of construction, and risks are increasingly transferred to the private sector.¹³⁹ The central line, the Tokaido Shinkansen network, transports up to 150 million passengers annually,¹⁴⁰ and greatly reduces travel time. The Shinkansen network has brought a wide range of social and environmental co-benefits, including reducing traffic accidents and carbon emissions. Shinkansen has had zero fatalities since its inception in 1964.¹⁴¹ Travelling the same distance, cars emit more than seven times the amount of CO₂ than the Shinkansen trains.¹⁴² China is also building an extensive high-speed rail network across the country to promote economic and social interactions between cities.

In less developed countries, the transport infrastructure for city clusters is less well designed and well planned. However, there are significant opportunities to plan and build and connect future city clusters in a smarter way. It will be critical for countries to design corridors in a way that supports efficient transport connectivity, to unlock their full economic potential.

Re-densification

Over the last decade, re-densification has been taking place in a range of global megacities and mature cities,¹⁴³ including London, Brussels, Tokyo, Hamburg and Nagoya. These cities have moved back towards more concentrated forms, partly as a result of land use regulations and investment in public transport. London, for example, built more than half of its newly constructed floor area within walking distance of the nearest subway stations between 2004 and 2011.¹⁴⁴ Similarly, Beijing is going against the overall trend of de-densification: population density in Beijing's core increased by 50% between 2000 and 2010.¹⁴⁵ The city, together with 13 other major Chinese cities, will further control excessive urban expansion by determining boundaries for urban development.¹⁴⁶ In the US, there is also a trend towards building more compact and connected neighbourhoods, called the "New Urbanism" movement.¹⁴⁷

6. Scaling up changes: overcoming barriers to scaling up of sustainable transport

Although technological advances and innovations are available to support the scaling up of transformed urban mobility systems, countries and cities face significant barriers in the transition to more sustainable transport systems. First, NMT and public transport options can often require upfront infrastructure investment, even though the capital incremental requirements can be modest compared with alternatives such as road systems, and these can often be challenging to source given the limited revenue bases in many developing and emerging countries.¹⁴⁸ The budget deficits and significant debt levels of many national and local governments make financing for building or upgrading infrastructure even more difficult. For mature cities, the switching costs to more transit-oriented urban form can be high, particularly for low-density and car-oriented urban areas.

Second, strong consumer preferences towards cars and associated lifestyles hinder the pursuit of more compact and transit-oriented urban development. This is increasingly pronounced in emerging economies and developing countries, and can be attributed to rising incomes and changing social perceptions that regard cars and big houses in suburban areas as symbols of being rich and successful.

Another barrier is from vested interest groups, particularly the automotive sector. Reducing car dependency and ownership is likely to have detrimental impacts on automobile manufacturers. This barrier is more pronounced in emerging countries that have large automobile components in their economies, such as China and India. In these two countries, for example, the automobile industry accounts for up to 7% of total GDP, and generates numerous employment opportunities.¹⁴⁹

In addition, fossil fuel subsidies artificially reduce the costs of the use of private motorised vehicles, hindering the transition to more efficient and sustainable transport systems. Subsidies provide disincentives to adopt modern, energy-efficient technologies in the transport sector. In the Middle East, for example, the average passenger car uses 60% more fuel per kilometre than the average car in the OECD does, due to high subsidies for petroleum.¹⁵⁰ The removal of subsidies to petrol in Saudi Arabia could reduce the payback period of efficiency upgrades from 16 to 3 years.¹⁵¹

A range of institutional and governance barriers also exist. It has not been widely acknowledged that institution and governance need to be changed for a paradigmatic shift towards sustainable mobility and compact urban forms, although there is increasing recognition of the important role that integrated urban land use and transport planning authorities can play. For example, Singapore has set up an integrated land use and transport agency – Land Transport Authority – for planning, operating, and maintaining Singapore's land transport infrastructure and systems. However, policy integration is often compromised by insufficient coordination between different departments.

Limited resources and capacity is also one of those institutional and governance barriers in scaling up non-motorised transport and public transport infrastructure, particularly in developing countries. Most cities in the developing world do not have the public finance to invest, maintain or operate such transport systems efficiently. Leveraging private finance through public-private partnership (PPP) or other economic instruments, such as land value capture, could narrow the financial gaps, but requires stronger institution and governance for effective implementation.

Cities at different stages of development face different barriers, and require tailored strategies and policy instruments to overcome their barriers and achieve more compact urban growth and more sustainable transport systems.

7. International collaborative initiatives on urban transport

In recent years, the critical importance of the urban transport sector to sustainable development goals has been recognised by several national and global processes and has spawned several collaborative initiatives.

International cooperation can help cities to overcome the existing barriers mentioned in the previous section, and can amplify and accelerate action by developing common platforms for action, knowledge-sharing and capacity-building, and by enhancing cities’ access to finance for sustainable transport. Noteworthy international initiatives in the transport sector are listed in the table below. Many of these are climate focused, but the evidence above clearly demonstrates the wider economic and social benefits that are likely to be unlocked through these initiatives which should be better captured.

Table 5
International initiatives in the transport sector

International initiative	Objective	Opportunities	Challenges to scaling up
Rio+20 Financing Commitment by MDBs	Eight of the largest multilateral development banks (MDBs) have committed to investing US\$175 billion in sustainable transport systems over the coming decade at the United Nations Conference on Sustainable Development (Rio+20) in June 2012	<ul style="list-style-type: none"> Acknowledges that “transportation and mobility are central to sustainable development”¹⁵² Unprecedented commitment by international community that can catalyse investments in sustainable transport Shifts priorities of MDBs towards health, environmental and economic benefits and inclusiveness of sustainable transport 	<ul style="list-style-type: none"> US\$175 billion is but a small fraction of transport sector investment needed globally MDBs need to clearly define what constitutes sustainable transport and the key indicators to evaluate it Countries should have capacity to leverage this funding and align it with private finance and national transport programmes and policies
Compact of Mayors	Through the Compact, city leaders pledge to reduce their city-level GHG emissions, track their progress, reduce vulnerability and enhance resilience to climate change through a transparent process that is consistent and complementary to national-level climate protection efforts ¹⁵³	<ul style="list-style-type: none"> Sets GHG reduction targets for cities, with robust, rigorous and consistent standards to report progress publicly City governments commit to take action towards national climate targets and to be held accountable Encourages national governments to commit both resources and policy for city-level climate action Can trigger change in urban transport programmes and policies in participating cities 	<ul style="list-style-type: none"> Many cities, particularly those in developing countries and smaller/secondary cities, typically lack technical and financial capacity to be able to participate fully in such a process New voluntary initiative that currently under-represents some regions, such as South Asia, which have a rapidly growing urban population
Paris Process on Mobility and Climate (PPMC)	Comprising over 150 diverse organisations from multiple stakeholder groups working on sustainable mobility, the PPMC is an open and inclusive platform for effective action on transport and climate change, aiming to influence the UNFCCC process and COP21 ¹⁵⁴	<ul style="list-style-type: none"> PPMC is engaging stakeholders contributing to climate action with a focus on improving mobility PPMC provides technical analysis, for example of the recent Intended Nationally-Determined Contributions (INDCs) committed by countries 	<ul style="list-style-type: none"> PPMC analysis shows the INDCs collectively fall short of the goal of remaining within a 2°C climate change scenario Although 85% of INDCs mention urban transport measures, much needs to be done to scale up the transport mitigation ambition of countries and the strategies they commit to¹⁵⁵

International Association of Public Transport (UITP) Declaration on Climate Leadership	UITP's goal is to double the market share of public transport use around the world by 2025, resulting in a massive shift to public transport, which would prevent the emission of half a billion tonnes of CO ₂ equivalent in the year 2025 ¹⁵⁶	<ul style="list-style-type: none"> Through this initiative, UITP members are making voluntary commitments to reduce carbon emissions and strengthen climate resilience within their cities and regions by scaling up and improving public transport 	<ul style="list-style-type: none"> Initiative must be aligned with others mentioned above, such as Compact of Mayors (city scale), the COP21 national commitments, and global urban SDG process Requires significant investment in public transport, financing and technical capacity and, above all, the political will to prioritise public transport over private vehicle interests
UN Sustainable Development Goals (SDGs) Process	Goal 11 focuses on making cities inclusive, safe, resilient and sustainable	<ul style="list-style-type: none"> Prioritises city-level action Includes target to provide access to safe, affordable, accessible and sustainable transport systems for all¹⁵⁷ 	<ul style="list-style-type: none"> Need for immense policy, capacity, and financing support well aligned across global, national and city scales

There are many other initiatives not mentioned in the table that can play a key role in supporting local, regional, national and global action on the economy and climate through crucial policies, investments and programmes in the transport sector (see Annex for additional initiatives). The key challenges are to ensure:

- i. strong local capacity to engage and follow through with the required action
- ii. national government support, finance and enabling policies
- iii. alignment of local and national transport actions with national climate commitments and commitments to meet the SDG targets
- iv. accountability through effective performance measurement with financial and other incentives for good performance.

8. Recommendations for policy-makers

The economic, social and environmental case for investing in better urban transport systems both within and between cities is compelling. As the various NCE reports have demonstrated, this model of more connected, compact urban development can be more productive, socially inclusive, cleaner, quieter and safer. The decisions that national decision-makers and cities take within the next 5–15 years will be critical to capturing these benefits.

To facilitate this transition, we set out our recommendations as follows.

National and city-level decisionmakers should:

- Consider setting up integrated transport and land use authorities to plan urban growth and scale up public transport, cycling, walking and spatially efficient use of low-carbon vehicles, with nations playing a key role in empowering local authorities with the powers to act.
- Strengthen strategic planning at the city, regional and national levels, with a focus on improved land use and integrated multi-modal transport infrastructure.
- Reform fuel subsidies and consider introducing new pricing mechanisms such as road user charges to reduce and eventually eliminate incentives to fossil-fuelled vehicle use.
- Consider charges on land conversion and dispersed development, and measures that place a higher price on land than on buildings such as land taxes and development taxes. These reforms can raise revenue to invest in public transport and transit-oriented development.

- Introduce new mechanisms to finance upfront investments in smarter urban infrastructure and new technology. These may include the creation of dedicated national, regional or city-level investment platforms to prepare and package investments to attract private-sector capital into the transport sector.
- Demonstrate leadership by committing to ambitious emissions reduction targets and/or low-emissions development strategies, with cities worldwide aiming to comply with the framework of the Compact of Mayors by 2020 and nations aiming to introduce national legislation to support and incentivise the adoption of emissions reduction targets and/or low-emissions development strategies, including developing national urbanisation strategies in conjunction with city government, prioritising policies and investments in public and non-motorised transport.

The **international community**, working with national governments and cities, should:

- Help to accelerate and scale up these efforts by developing an integrated package worth at least US\$1 billion over five years to support at least the world's largest 500 cities by 2020 to:
 - i. comply with the Compact of Mayors;
 - ii. strengthen capacities for project preparation, including for urban transport;¹⁵⁸
 - iii. enhance creditworthiness to underpin large-scale urban infrastructure investments, including in the transport sector;
 - iv. access climate finance more directly to cover the incremental upfront costs of sustainable transport projects and other low-carbon investments when agreed in partnership with nation states.
- Provide enhanced platforms for knowledge-sharing and technology transfer among cities – for example, through supporting global city networks such as C40, ICLEI and UCLG – to create local demand for sustainable transport financing.¹⁵⁹
- Make a stronger political commitment to sustainable transport, including taking steps to strengthen existing international collaborative initiatives. The largest investments continue to be directed at large-capacity road projects aimed at improving vehicle flows. Decision-makers within the international community, as well as at the state, regional and local levels must demonstrate a renewed commitment to targeting investments towards sustainable transport. City leadership is playing a more prominent role, locally by articulating a vision of how to improve quality of life and well-being of citizens. This needs to be complemented by leadership at the international level.
- Promote improved quantification of wider co-benefits and evaluation of performance. The significant social and economic benefits and wider co-benefits of investing in low-carbon transport and transport for sustainable development must be measured objectively and better emphasised to decision-makers. Current decision-making processes typically fail to take into account the full economic, social and environmental consequences of policies, programmes and projects. There is a need for cities and countries – with support from the international community – to establish clear and consistent performance outcomes to assess the impacts of funded projects, using indicators of health, safety, equity, access, environmental quality and economic productivity.

Many of these recommendations build on those presented in the 2014 and 2015 NCE reports.¹⁶⁰

ENDNOTES

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ABOUT THE NEW CLIMATE ECONOMY

The Global Commission on the Economy and Climate, and its flagship project The New Climate Economy, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change.

In September 2014, the Commission published *Better Growth, Better Climate: The New Climate Economy Report*. Since then, the project has released a series of country reports on the United States, China, India and Ethiopia, and sector reports on cities, land use, energy and finance. In July 2015, the Commission published *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate*. It has disseminated its messages by engaging with heads of governments, finance ministers, business leaders and other key economic decision-makers in over 30 countries around the world.