LEDS GLOBAL PARTNERSHIP

# LEDS in Practice

May 2016

# Breathe clean

## by reducing greenhouse gas emissions from urban transport

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## Key messages

- Air pollution not only diminishes the quality of life in cities around the world, but also threatens the prosperity of urban economies.
- Particularly hazardous for health are emissions of black carbon, a component of particulate matter, which is a known cause of respiratory diseases, is carcinogenic, and is also a significant contributor to global climate change.
- The clear links between greenhouse gas emissions and particulate matter make low carbon transport an increasingly sustainable investment at local level—both by reducing emission levels and thus mitigating climate change; and by improving public health through cleaner air.[1]
- For example:
  - Congestion pricing in Stockholm, Sweden saves 14–18% of carbon dioxide ($CO_2$) equivalent emissions, cuts particulate matter by 9% and mono-nitrogen oxides by 7%—and generates revenue.
  - Policy proposals in Nepal's Kathmandu Valley to reduce particulate matter are aiming to reduce bronchitis cases and asthma attacks, bringing massive economic savings of US$21 million for the nation, along with major improvements in quality of life.

## Introduction

This paper presents two case studies from cities that have taken action on air quality to improve public health and have realized the benefits of reduced emissions with the implementation of low carbon transport policies.

Also in the LEDS GP series on the benefits of reducing greenhouse gas emissions from urban transport:

- *Make roads safe*
- *Save money and time*
- *Create jobs*
- *Fight poverty*

This series of short papers aims to demonstrate how low carbon transport options can support national and local development agendas efficiently.

As well as accounting for 23% of the world's energy related greenhouse gas emissions, fossil fuel consumption by motorized transport releases exhaust fumes that contain particulate matter (PM) including black carbon, which is hazardous to human health and a contributor to climate change. Along with methane, tropospheric ozone and some hydrofluorocarbons, black carbon is one of the short lived climate pollutants.[2] These pollutants remain for a much shorter lifetime in the atmosphere than carbon dioxide, but they account for 30–40% of today's global warming.[3] In 2000, about 20% of global black carbon emissions were emitted from land transport and international shipping sources.[4] The United Nations Environment Programme estimates that each year 2.4 million premature deaths from outdoor air pollution could be avoided, and by 2050 global warming could be reduced by up to 0.5°C if short lived climate pollutants are mitigated promptly.[5]

Shifting to low carbon transport plays a crucial role in the fight against air pollution as transport accounts for 27% and 22% of total global $PM_{2.5}$ and $PM_{10}$ emissions, respectively.[6] Low carbon transport solutions would achieve three interlinked benefits:

- improve health and reduce premature deaths
- avoid the resulting loss of economic productivity and related healthcare costs
- slow the rate of near term climate change.

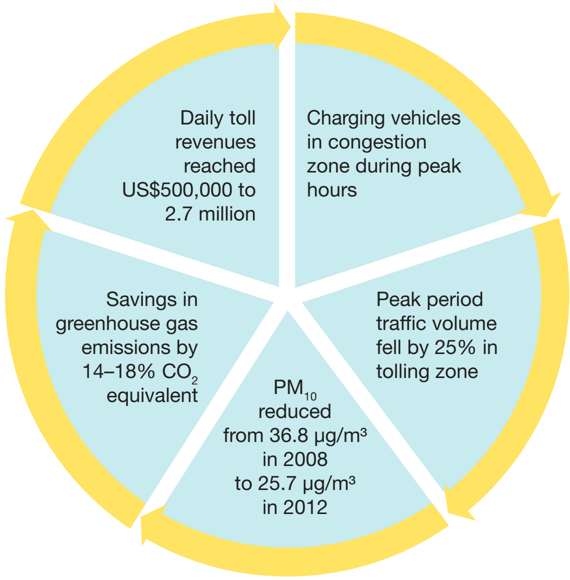
Particulate matter (PM) is a mixture of small particles of acids, organic chemicals, soil, metal, or dust, usually categorized by size: $PM_{10}$ (less than 10 micrometers in diameter) or $PM_{2.5}$ (less than 2.5 micrometers in diameter). The human body cannot protect against exposure to ultra-fine particles like $PM_{2.5}$.

Epidemiological and toxicological studies find strong evidence that vehicle emissions are related to clinically significant health ailments.[7] High atmospheric concentrations of tropospheric ozone and black carbon increase the risk of many respiratory and cardiac diseases—placing an immense burden on healthcare systems.[8] Children, pregnant women, and the elderly are especially vulnerable to outdoor air pollution, with several severe impacts on their health and development.[9] And a recent study showed that the risk of hospital readmission for children with asthma was 21% higher for children with high exposure to traffic related air pollution than for those with lower exposure.[10]

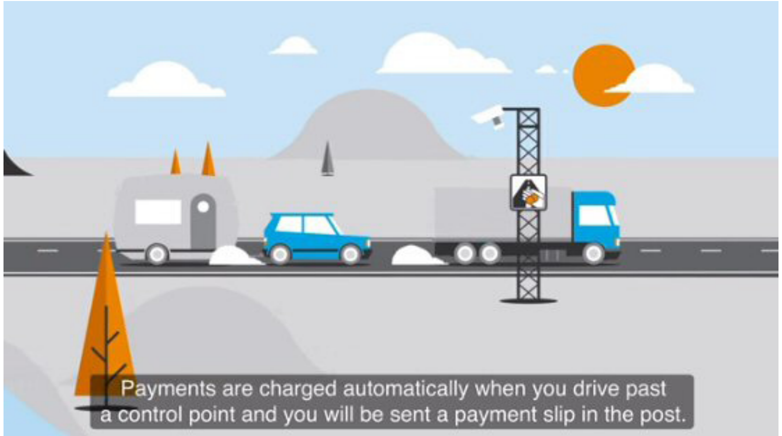
## Case study
### Congestion pricing in Stockholm, Sweden

Stockholm introduced a congestion pricing system in the inner city in 2006 to reduce traffic and vehicle pollution. The aim was to distribute the traffic flow entering the city center uniformly throughout the day and reduce congestion during peak hours. With a variable charging system, Stockholm achieved its goal of

Figure 1 Benefits of low carbon congestion pricing in Stockholm[11]



Transport Styrelsen




cutting greenhouse gas emissions and improving the ambient air quality within the congestion zone.[12]

Entering the inner city area of Stockholm by private vehicle costs 15 krona[13] (about US$1.77) on workdays, with a doubling of the tax at peak hours. Between the evening and morning rush hour, as well as on weekends and holidays, driving into the congestion zone is free.[14] The congestion pricing system supports low carbon mobility patterns that save 14–18% of $CO_2$ equivalent emissions annually.[15]

Since 2008, the air quality stations in the city have registered a downward trend in $PM_{10}$.[16] At the city's Hornsgatan station, $PM_{10}$ emissions reduced from 36.8 µg/m³ in 2008 to 25.7 µg/m³ in 2012.[17] It was estimated that with the implementation of the congestion charge there would be 20–25 fewer deaths annually in the inner city and 25–30 fewer deaths in the metropolitan area.[18]

This variable pricing system allows the city to control the traffic flow in the congestion zone, and at the same time generates daily revenues of US$500,000 to $2.7 million—money that is reinvested in low carbon transport options such as new bus lines and expansion of the bicycle lane network.[19] This translated into an 18% reduction in traffic volumes in 2011, while the public transport system experienced a 9% increase in ridership compared with 2005, equivalent to 80,000 users per day.[20] In addition, the exemption of cars using alternative fuel from the congestion tax (along with taxis, buses, and foreign cars) incentivized increased ownership of low carbon vehicles. By 2008, 13% of vehicles registered in the congestion zone were alternative fuel cars, compared with only 3% during the trial phase in 2006.[21] In an innovative revenue model, the funds generated through congestion pricing feed back into the loop, funding more low carbon transport solutions that are proven to improve air quality and public health.

# Case study
## Local air pollution management in Kathmandu Valley, Nepal*

With a gross national income of US$260 per capita, Nepal is one of the poorest countries worldwide.[22] Nepal is the fastest urbanizing country in South Asia with an annual growth rate of 7%.[23] The Kathmandu Valley is home to 1.8 million people, 30% of Nepal's population, who suffer from exposure to poor air quality.[24] The annual mean concentration of $PM_{10}$ in 2008 was 114 µg/m³, well above the World Health Organization (WHO) annual mean guideline of 50 µg/m³.[25]

The rapid urban migration between 1998 and 2004 increased demand for motorized travel in the cities of the Kathmandu Valley 8.7-fold during this period, with a rapid increase of pollutants emitted by those vehicles. Projections predict that this trend will continue.[26] By 2030, the population is estimated to reach 3.3 million people, a development that goes hand in hand with a tripling of motorized travel demand by 2025.[27] This translates into an annual motorization rate of 12%,[28] such that the number of vehicles operating

* Facts presented in this case study are from studies completed prior to the April 2015 earthquake in Nepal. Some facts are likely to differ now.

on Kathmandu's roads will reach half a million compared with 170,000 vehicles in 2004,[29] bringing harmful quantities of air pollutants.

Photo credit: Sirensongs

Public transport vehicles in Kathmandu Valley are mainly buses and minibuses. Public transport meets 37% of the total travel demand in the urban areas while consuming only 13% of the total energy consumed by the urban transport system. In contrast, private motorized trips by car and motorcycle account for a 53% share of the total energy demand.[30]

These two factors—the increase in private motorization and the relatively higher energy consumption of private vehicles—are clearly reflected in the increase in transport related $CO_2$ emissions: 5.2-fold since 1989, with a further doubling projected by 2025. Likewise, $PM_{10}$ emissions increased about 4.5-fold since 1989 and today's concentrations alarmingly exceed the air quality guidelines set by both WHO (50 µg/$m^3$) and the National Ambient Air Quality Standards of the US Environmental Protection Agency (150 µg/$m^3$).[31] The resulting health impacts are worse in winters due to low dispersion. Transport related air pollution contributes to 1,600–1,900 premature deaths in the valley each year.[32]

In the Kathmandu Valley, the transport sector is responsible for about a third of the total $CO_2$ emissions from fuel combustion, and vehicle emissions account for 38% of total $PM_{10}$ emissions.[33] Thus moving to a low emission urban transport system is an important component of the fight against air pollution.

A 2005 survey compared five alternative policy scenarios with a business as usual scenario, and concluded that a comprehensive low carbon policy package was needed to address the nexus of increased motorized travel demand and transport related air pollution in the Kathmandu Valley.

The measures proposed in the policy package include:

- shift to low carbon public transport with a 65% trip share by 2025, with public transport comprising 80% of high occupancy vehicles
- gradually enforce Euro 2 emission standards and reduce sulfur content in gasoline and diesel to 500 ppm
- gradually convert all three-wheelers from gasoline powered to electric powered by 2025
- reduce population growth by 10% by 2025 (compared with business as usual) while promoting urban density over urban sprawl
- improve passenger comfort on public transport.[34]

Estimates suggest that these measures together would cut $CO_2$ emissions by 20% and reduce $PM_{10}$ emissions 47% by 2025 compared with business as usual.[35] If nearly 145,000 vehicles (26%) are off the roads by 2025, energy consumption by the urban transport sector will fall by 18%.[36] For instance, shifting 1 km traveled by private motorized vehicles to low occupancy public transport (minibuses) would result in a 36% reduction in $PM_{10}$ emissions. Choosing high occupancy public transport (buses) instead of low occupancy modes would decrease $CO_2$ emissions per kilometer traveled by 77%.[37]

Reducing the $PM_{10}$ concentration in Kathmandu Valley to a level that meets international health standards could reduce acute childhood bronchitis by 135,475 cases; avoid half a million asthma attacks; and cut chronic bronchitis by 4,304 cases,[38] bringing massive economic savings of US$21 million for the nation, along with major improvements in quality of life.[39]

## Conclusion

Pursuing the local priority of fighting urban air pollution also addresses the global goal of mitigating climate change.[40] By introducing solutions that support low carbon mobility and travel behavior, people's exposure to traffic related air pollution can be reduced significantly. The synergy between sustainable urban mobility and air quality means that low carbon transport presents a case for local leaders to ensure healthy development for their citizens, savings on healthcare costs, and contributions to both the environmental health of cities, and climate change mitigation and adaptation.

## Notes

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Front cover photo by Simone D. McCourtie/World Bank
Editing, design, and layout: Green Ink (www.greenink.co.uk)