EXECUTIVE SUMMARY

Around the world, cities face enormous problems of transport sustainability. Rapidly increasing populations and vehicle use have created gridlock and sprawl, even in very poor cities, as well as rapid growth in oil use and unacceptably high levels of air pollution. This book shows how better bus systems, incorporating new approaches to system design and new technologies, can put urban transportation on a more sustainable path. It covers three areas: new bus systems, new bus technologies, and profiles of a number of cities around the world that are tackling very difficult traffic-related problems.

Compared to cities dominated by small private vehicles, those with well-designed bus systems have much less traffic congestion, lower pollutant and CO_2 emissions, and offer better mobility for all social and economic classes. Bus systems in the developing world carry a large share of urban travellers but are responsible for only a small part of traffic congestion, energy use and pollution. This is because reasonably full buses are inherently efficient – in terms of both road space and fuel use per passenger kilometre. Even "dirty" buses emit far less pollution and CO_2 emissions per passenger-kilometre than most other types of vehicles. But transit shares of travel are declining in many cities and conditions are worsening. Changing these trends and moving toward more sustainable transport is imperative. Our analysis indicates that for a city like Delhi, there is a 100% difference in oil use and CO_2 emissions between a future transport system dominated by travel in high-quality bus systems and one that is dominated by private vehicles.

While many new technologies are emerging to improve buses, perhaps the most important story to be told is that the systems in which buses operate can be dramatically improved. Bus transit can be a premier form of urban travel. A new paradigm in delivering bus services, becoming known as *bus rapid transit*, is being developed in a number of cities, particularly in Latin America, and shows promise for revolutionizing bus systems around the world. Getting buses out of traffic, increasing their average speeds, improving their reliability and convenience, and increasing system capacities can ensure high ridership levels and increase the profitability of systems.

Once buses are moving and providing a service that attracts riders, then the question of bus technology does indeed become important. A dizzying array of new bus propulsion systems and fuels has emerged in recent years, but Chapter 3 lays out the key facts for several of the most important options. Policy makers and bus operators in both the developing and developed world may find this discussion useful, with sections on "clean diesel", biodiesel, gaseous fuels, hybrid-electric engines, and fuel cells. The concluding section illustrates the wide range of costs of different options and provides a technology "ladder" – a pathway toward cleaner buses that starts with inexpensive, relatively straight-forward measures and reaches much more expensive and complex measures, such as fuel cells, that may eventually become cost-effective.

All in all, the package of improvements described in this book, and being tested and implemented in various cities around the world, holds the potential to make all cities more efficient, cleaner, less gridlocked and more sustainable. But it will not be easy. It will require technical assistance and the transfer of experience and learning from successful cities to those just starting out. Perhaps most of all it will require political will.

KEY MESSAGES

Each additional bus, if reasonably full, provides large social benefits through mode-switching and a reduction in traffic. Regardless of whether a bus is "clean" or "dirty", if it is reasonably full it can displace anywhere from 5 to 50 other motorised vehicles, including often very dirty two-wheelers as well as cars. In some developing cities the primary displacement is of high-emission motorcycles and scooters. The fuel savings, CO_2 reductions and air pollutant reductions from switching to bus travel can be large – possibly much larger than those from making a fuel change or technology upgrade to the bus itself.

The collective impact of bus system reform on world oil use can be large. Transport drives oil demand and transport is growing three times faster in developing countries than in developed countries. Since bus system reform will substantially cut oil use in the large urban centres of developing countries,

where transport demand is growing quickly, the collective impact of sustainable bus transport can be as important as any other strategy to reduce world oil demand.

Development of "Bus Rapid Transit" (BRT) systems in Latin America opens a new era in low-cost, high-quality transit. Bus systems in cities like Curitiba (Brazil) and Bogota (Colombia), with dedicated lanes, large-capacity buses, and specialised bus stations that allow pre-board ticketing and fast boarding, are a quantum improvement over standard bus systems. Average travel times have been reduced substantially and the overall travel experience for most riders greatly improved. The system in Bogota, though only three years old and still under development, already has one of the highest ridership rates in the world. Most large cities would benefit greatly from bus rapid transit systems.

The institutional, financial and operational aspects of bus systems must be strengthened. In many poor cities, most buses are run by small independent companies, some of which survive from day to day. These companies are rarely able to make major investments. Systems must be reformed to improve service and profitability, by moving from "bus versus bus" competition on the same route to competition for a licence to serve entire routes. The level of service required for the entire route should be specified in the contract, and provision of this service should be assisted by supporting policies, such as adequate fares.

Testing of new bus systems in "demonstration corridors" is an important step. Pilot or demonstration projects can create the "seed" that later grows into a fully established system of bus rapid transit routes. Demonstration projects can include dedicated bus lanes, improved bus stops and terminals and new ways of licensing and regulating bus services on the route. They can also offer a showcase for advanced technologies, or simply modern buses.

New, low-cost bus-system technologies can help. When lanes and entire corridors are given over to buses, bus travel becomes increasingly attractive. With such additional features as bus priority treatment at intersections and traffic signals, buses can become a premium form of urban travel, rather than a last resort. Global positioning systems (GPS) to track bus position and relay

this information to travellers in real time, so they know when buses will arrive, are also becoming cost-effective. "Smart card" ticketing systems can allow easy transfers and multiple trips with one electronic fare card. In such cases, technology "leap-frogging" makes good sense for many cities in the developing world.

Transit-system improvements pave the way for bus-technology improvements. If bus companies are to justify the expense of investing in new-technology buses, those buses must earn higher revenues than current buses. Revenues can be increased through fuller buses (carrying more passengers per kilometre), faster buses (more kilometres covered per day, and more passenger boardings) and higher fares. Increasing bus ridership requires system improvements and policies that encourage public transit. Similarly, speeds can be increased by system improvements, such as dedicated bus lanes. Higher fares may be justified once the quality of bus travel improves. All of these steps may help increase the revenues generated by each bus. This is critical to enable transit agencies and bus companies to afford better buses with better emissions-control systems, and in some cases to pay for alternative-fuel infrastructure.

Bus operators should gradually "move up the ladder" to advanced bus technologies. Fuel-cell buses and hybrids are too expensive today for most developing countries. But there are many lower-cost steps that can be taken to obtain cleaner, more efficient buses. Strategies to clean up existing buses quickly include better bus maintenance and improvements in fuel quality. Incremental improvements to the design of diesel engines, control systems and after-treatment systems (in conjunction with a shift to low-sulphur diesel fuel) can reduce diesel emissions dramatically. In some cities, it may make sense to concentrate on moving to alternative fuels such as compressed natural gas or liquid petroleum gas. This depends on the availability and cost of these fuels and fuel-delivery infrastructure. It also depends on the availability of affordable alternative-fuel buses. In other cities, it may be better to focus on cleaning up diesel fuels and buses, and eventually move to advanced diesel hybrid-electric buses. Some day, most buses may run on hydrogen, but it is still too early for most cities to worry about developing hydrogen refuelling infrastructure. Bus operators need to gain experience by taking incremental steps up the "technology ladder".

Field tests of different options and in-situ data-gathering are essential. Using emissions factors and models from one city to simulate emissions in another is unsatisfactory. Each city needs to understand it's own emissions patterns, how different vehicles affect air quality, and what changes are most important. Part of this process includes testing various vehicles and technologies under local conditions. A well- designed plan to establish baseline conditions and estimate the impacts of alternative measures is an important part of any process to develop better bus systems and introduce new bus technologies.

Improved buses and bus systems should be part of a comprehensive strategy. Improving buses and bus systems will help increase the bus share of passenger travel in cities around the world. But unless strong policies to dampen the growth in car travel and, in many places, motorcycle travel are *also* applied, the fight for sustainable transport will be a losing battle. Increasing vehicle and fuel taxes, strict land-use controls and limits and higher fees on parking are important to ensure a sustainable urban transport future. Equally important is integrating transit systems into a broader package of mobility for all types of travellers, for example non-motorised vehicle lanes. Pedestrians and bicyclists are important users of transit, if they can get to it. Finally, all travel is rooted in the electric-drive structure of a city. Electric-drive development should be geared toward avoiding car-dependence and putting important destinations close to public transit stations (and vice versa).

The IEA's six case studies show that improving bus transit systems is possible, but not simple. It is complicated by the many stakeholders in each city, each with different points of view and degrees of influence; and it is complicated by the often confusing array of government agencies with some say in what initiatives occur and how they occur. Still, in all six of the cities reviewed some progress is being made to improve bus transit systems. But it will be difficult for cities to "go-it-alone". International support and technical assistance, especially from those cities that have been the most successful, will be needed to speed progress.