

Sustainable Transport for APEC Megacities: Issues and Solutions

Vol. I Summary Report



Asia-Pacific Economic Cooperation
APEC Industrial Science and Technology
Working Group



The APEC Center for Technology Foresight
National Science and Technology Development Agency
Bangkok, Thailand
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Published for the APEC Secretariat by:
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Website: <http://www.apecsec.org.sg>

APEC # 00-IT-01.1

ISBN 974-7579-80-4

Printed and bound by Jirawat Express Co., Ltd, Bangkok, Thailand

Designed by
The Public Information Department
Thailand's National Science and Technology Development Agency
www.nstda.or.th
Bangkok, Thailand.
February, 2000

Foreword

The APEC Center for Technology Foresight was launched in Bangkok on 3 February 1998. The objectives of the Center are to:

- Promote the adoption of technology foresight across APEC member economies.
- Provide a means for comparison of technology foresight exercises and implementation in APEC member economies and across the world, with a view to stimulation of Best Practice in appropriate methodologies for Foresight in APEC economies.
- Conduct technology foresight exercise on an APEC-wide basis, and between relevant member economies.
- Improve the quality and effectiveness of technology-related planning and development and priority-setting for research, across APEC member economies.
- Develop a technology foresight research and application capability available to APEC member economies and International agencies.

The Center has adopted the following definition of Foresight:

“Foresight involves systematic attempts to look into the longer-term future of science, technology, the economy, the environment and society, with a view to identifying emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic, social and environmental benefit.”

The Center is currently tackling the issue of Sustainable Megacities in the APEC context. Urbanisation has been particularly pronounced in the Asian and Pacific region in the second half of the last century. By the year 2025, Asia will become predominantly urbanised with an urban population of 2.5 billion or 55% of the total population, and 20 of the world’s megacities, with population exceeding 10 million, will be in Asia.

Megacities have both positive and negative values. They generate higher-than-average proportions of their economy’s output of goods and services; are centers of innovation in science, the arts and lifestyles; contain many of the cultural assets of the economy and offer some of the better opportunities for people to lead full and satisfying lives. Yet they also offer potential shortages of water, environmental pollution, traffic congestion and a proliferation of slums, crime and social alienation.

The APEC Center covered issues of urban water supply and management in its first study “Water Supply and Management in the APEC Region,” published at the end of 1998. The topic of “Sustainable Transport” was chosen for study in 1999 as another major component of the issue of Sustainable Megacities. The other one is “Healthy Futures for APEC Megacities.” The aim was to involve as many APEC economies and their Experts as possible to produce an outcome relevant to all APEC economies. The approach was to have a Discussion Paper prepared in April 1999 by a Consultant and then bring together a group of Experts in Melbourne, Australia on 27-29 July 1999 to analyse the issues and develop scenarios. Based on these inputs, literature research and discussions with transport authorities in Thailand, the Consultant produced two draft reports for comment in late 1999. The essential steps in the process and the outcomes are set out in Volume 1, which is essentially for policymakers and their advisers. The full report of the study is reported in Volume 2.

The Experts’ Meeting drew together 16 experts from 7 economies and we are particularly grateful to them for giving their time and experience, and to their economies which supported them. The Consultant, Mr. Ainsley Jolley from the

Centre for Strategic Economic Studies (CSES) of the Victoria University of Technology, Melbourne, Australia carried the bulk of the effort in producing material for the study and we thank him for his outstanding contribution. The staff of CSES supported him admirably and we wish to thank Professor Peter Sheehan for his encouragement and Ms Margarita Kumnick and Ms Gordana Volkanovska for their work in organising the Experts' Meeting and producing a Meeting summary for the participants. We are very grateful to Professor Ron Johnston for carrying the demanding role of facilitator at the Meeting.

The Australian Government, through the Department of Industry, Science and Resources made a generous financial contribution to assist attendance of APEC Experts and the cost of the Workshop. The study has been supported by funding from the APEC Central Fund and from the APEC Center budget which is provided by the Royal Thai Government. We are grateful to our colleagues from the APEC Center for their dedicated support.

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Executive Summary

This report describes a multi-country Foresight study, on the subject of Sustainable Transport, conducted by the APEC Center for Technology Foresight located within the National Science and Technology Development Agency in Bangkok, Thailand. A process of literature review, issue identification, scenario development and analysis involved experts in sustainable transport from seven APEC member economies.

Sixteen key issues were identified for the future of sustainable transport to 2020:

- Impact of post-industrial economy-change in characteristics of employment and leisure
- Impact of e-commerce and other 'non-transport' technologies
- Impact of environmental and energy supply considerations-greenhouse gas targets
- Balance between public and private transport
- Degree of continued reliance on motor vehicle
- Management of traffic demand
- Transparency and awareness of full cost of options
- Development of intelligent transport systems
- Funding (including subsidies) to transport
- Interaction between land use and transport planning
- Heterogeneity-different solutions for different countries
- Transport infrastructure provision
- Institutional reform
- Changes in professional praxis of transport planning
- New transport technologies
- Human and community dimensions-equity, social and environmental costs, safety concerns

Scenarios identified three different futures in which environmental concerns dominated, in which a world recession and reduction of greenhouse gas emissions triggered a social change, and in which worldwide computer problems and oil crisis forced a simpler lifestyle.

The study has highlighted policy issues as the more significant, with technologies seen to be the means to achieving desirable outcomes. Thus the three major areas identified for attention by governments at all levels are:

- reprioritisation of transport infrastructure towards public transport;
- land use planning linked to transport planning to move away from low density sprawl;
- development of alternative growth centers to relieve growth in existing cities.

Technological opportunities likely to play the biggest role in supporting these policy thrusts are:

- development of electric and hybrid vehicles
- intelligent vehicle-highway systems
- new types of transit vehicles
- alternative urban freight distribution systems
- transport logistics

Finally, there is clearly a need for a new paradigm in the approach to the private motor vehicle and its role in urban transport. This paradigm will be based on a recognition by society that urban transport by private vehicles produces enormous social and economic disbenefits and that a mindset change to travel is needed.

1. Introduction

The APEC Center for Technology Foresight, was established in February 1998 with the objective of serving and involving all APEC member economies in diffusing technology foresight expertise across the APEC region.¹ However, the aim is not just to assist member economies with their own foresight efforts, but also to conduct research at a multi-economy level. Technology foresight may be able to contribute to issues which cross national boundaries—from air pollution, to chicken virus, to electronic information distribution.

Prior to the selection of topics for multi-economy study, the Center developed a number of criteria which any foresight study should meet: the issue must be of concern to most economies, with at least four agreeing to participate in the study; the issue must transcend national boundaries, so that it can go beyond what might be achieved by a national or bi-lateral study; there must be potential for sharing the results with all APEC members; the issue should be of general, public concern or benefit and not one that is likely to be dealt with by the private sector; and finally, the issue will have important technological components but not necessarily 'high-tech' ones.

The subject of Megacities as a topic for study emerged from discussions at a Technology Foresight Symposium held in Chiang Mai, Thailand in 1997 attended by over one hundred participants from sixteen different economies. It was agreed that issues of sustainability in Megacities would be increasingly important in the 21st century and that Foresight could assist policymakers and planners with resolution of problems. Its importance and relevance to the region cannot be disputed.

'Urban environmental conditions in the Asia-Pacific region are threatened by uncontrolled population growth, industrialisation and increasing vehicle densities. The economic impacts of pollution in Asian urban areas, in terms of productivity and health costs, have been estimated to range from 1 to 5 per cent of their GDP.' (Asian Development Bank 1998).

In early 1999 the APEC Center's International Advisory Board recommended that a study be commenced on the topic of Megacities and that in view of the social and economic issues associated with transport, it should be tackled first. The costs of traffic congestion in Asian cities are enormous:

'Estimated losses due to traffic jams, in terms of annual cost time delay, range from \$ 50 to 70 million in Manila, Jakarta and Kuala Lumpur to \$300 million in Singapore and Bangkok.' (Asian Development Bank 1998)

Based on a Discussion Paper prepared by a Consultant, an Experts Workshop in Melbourne in July 1999 identified sixteen issues in the future of sustainable transport as:

- Impact of post-industrial economy-change in characteristics of employment and leisure
- Impact of e-commerce and other 'non-transport' technologies
- Impact of environmental and energy supply considerations-greenhouse gas targets
- Balance between public and private transport
- Degree of continued reliance on motor vehicle
- Management of traffic demand
- Transparency and awareness of full cost of options
- Development of intelligent transport systems
- Funding (including subsidies) to transport

¹ More information can be found on the web site of the APEC Center for Technology Foresight <http://www.apectf.nstda.or.th>

- Interaction between land use and transport planning
- Heterogeneity-different solutions for different countries
- Transport infrastructure provision
- Institutional reform
- Changes in professional praxis of transport planning
- New transport technologies
- Human and community dimensions-equity, social and environmental costs, safety concerns

These issues were then tackled using the scenario technique in which small groups of experts identified likely developments and key drivers over the next 20 years. They then speculated on possible, even improbable events, which could occur to change the pattern of development, e.g. major political changes, wars, natural disasters, scientific and technical breakthroughs, and created scenarios to cover a range of futures.

In this case, ten key drivers were identified;

1. Demographics
2. World economics
3. Environment
4. Changing social demands and values
5. International standards
6. Fossil fuel availability
7. Technology development
8. Changing patterns of land use
9. Power of multi-national corporations
10. Flows of people due to war or disasters.

Identification of 'Uncertainties,' which can produce unexpected 'step-changes,' is a crucial step in development of scenarios. Sixteen uncertainties were agreed to at the Meeting:

1. Social change against vehicles
2. Political crisis in Middle East disrupting oil supplies
3. Rise in economic protectionism and collapse of trade
4. Shift by motor vehicle manufacturers from product to services
5. Information technology techno-terrorism
6. Global warming and coastal flooding
7. Transport-saving technologies
8. New supply of cheap oil
9. Global nuclear pollution
10. Collapse of international borders
11. Civil war in Asia
12. Pandemic of disease-influenza
13. New mode of personal transport
14. New cheap energy source-hydrogen
15. Solar flare destroys computer memories
16. Epidemic of computer virus

Based on this material, three scenarios were created. In the first, 'Green Light Ahead,' increasing concerns about environmental problems provokes significant political actions which trigger a technological response. Thus breakthroughs occur in the use of hydrogen as a fuel in vehicles using fuel-cells, the establishment of driverless people movers using intelligent road systems, and in tele-commuting.

In the second, 'Take The Train,' instability in world markets leads to a recession and loss of purchasing power, while concerns over greenhouse gas emission prompt actions to curb private motor vehicles. This triggers a social change against private transport and a shift to public transport based on bus and train networks.

In the third, 'Back To Basics,' world-wide problems with computer systems lead to massive dislocations to vehicle production. Coupled with an oil crisis provoked by instability in several oil-producing countries, private transport becomes a difficult option and people move back to simpler modes of transport and change their travel patterns. New concepts of public transport are developed.

Such scenarios provide a basis for exploring options for policy development and highlight areas of technology that should be explored.

2. Summary of Report

2.1 The Concept of Sustainable Transport

Sustainability, when applied to the development of countries, the growth of cities, or the evolution of transportation systems, means *capable of being continued*. Sustainable transport means finding ways of meeting transportation needs that are environmentally sound, socially equitable and economically viable.

To be economically sustainable, transport must be cost-effective and continuously responsive to changing demands. Cost-effective transportation is not easily secured because travelers are not directly confronted with many of the overall social costs associated with transportation. The combination of externalities and a lack of pricing of road space often gives rise to traffic congestion, a significant problem in many of the larger APEC cities (the net social costs of traffic congestion are estimated to be between two and three per cent of GDP in the advanced economies) and a major problem in many third world megacities (notably Bangkok, where costs could be as high as 8 per cent of regional gross product, and Mexico City).

Socially, sustainable transportation systems provide safe access and livability for all sections of the community. Transportation is of vital importance for all groups in the community for accessing jobs, education and health services. Accessibility is attained through the provision of comprehensive and affordable transport services. Most major cities in the APEC region have failed to meet this objective. Injury and death caused by road accidents is an important social cost associated with transportation, leading to losses estimated at between two and four per cent of GDP in the advanced economies. Sustainable transport should also help maintain or improve the quality of life in local communities.

Environmentally, sustainable transportation systems should: a) use energy resources and other natural resources at a rate not larger than rates of renewal of those resources; b) produce no more waste than can be accommodated by the planet's restorative ability; and c) make use of land in a way that has little or no impact on the integrity of ecosystems. At present, transportation systems in virtually all the major APEC cities fail to meet these criteria. Local air pollution, largely associated with the use of the motor vehicle, is one example of unsustainable transportation and could contribute as much as three per cent of GDP in terms of health costs in some cities in the advanced economies. The range of problems associated with transport emissions is greater in the cities of emerging economies because of the greater use of high-polluting vehicles and fuels. The external costs of road noise are around 0.3 per cent of GDP in advanced economies. The consumption of land and the environmental impact of transport infrastructure may also be significant but are more difficult to cost. Air pollution generated by city traffic can also have an impact on substantial regional areas. Emissions of sulphur and nitrogen compounds from transportation can lead to acidic rainfall, and contribute to acid fog and snowfall.

Pollution from motor vehicles produces about one-fifth of the incremental carbon dioxide in the atmosphere arising from human activity (which potentially contributes to global warming) and one-third of the chlorofluorocarbons (CFCs; these contribute to the depletion of the ozone layer). The global environmental effects of greenhouse emissions from transportation are estimated to be between 0.3 and 0.6 per cent of GDP. The transport sector now accounts for more than 60 per cent of global consumption of oil products. Current high rates of oil consumption by the transport sector are inconsistent with the maintenance of secure global oil supplies.

2.2 The Drivers of Change

The threat of increasingly unsustainable transportation systems in APEC mega-cities comes from the interaction between growing demand for transportation services and the environmental impact of transportation. Demand tends to grow at a geometric rate, while the environmental capacity (at given technologies) to handle such growth is fixed. Technology offers enormous possibilities for change in the longer run, but unless harnessed to the goal of sustainability, may aggravate some problems (such as traffic congestion) while in the process of fixing others (reducing emissions per road vehicle kilometre).

The demand for transportation services in the cities of the advanced economies tends to rise at a similar rate to the rise in real incomes. In the developing economies, demand for transportation rises much more rapidly for a number of reasons: the income elasticity of demand is usually well in excess of unity; per capita incomes are rising more rapidly than in the advanced economies; and urbanisation rates are rising more swiftly. In most countries, demand for travel is less responsive to prices than to incomes, and road vehicles account for an increasing proportion of total traffic. The OECD has prepared projections which indicate that, between 1990 and 2030, there will be an increase of 79 per cent in kilometres travelled by all vehicles within the OECD countries, and a rise of 312 per cent for countries outside the OECD.

The growth in urban traffic generates increasing waste outputs, assuming given technologies, which give rise to a range of environmental problems, local, regional and global. In practice, changes in vehicle technologies have led to some improvements in local air pollution, particularly in the advanced economies, and mainly with respect to emissions of carbon monoxide and lead. On current prospective trends, problems with emissions of nitrogen oxides, volatile organic compounds and suspended particulate matter will present health problems for a broad range of cities. Such emissions pose considerable health risks, ranging from respiratory ailments through to heart disease and cancer. Emissions of carbon dioxide still pose problems for attaining overall international greenhouse emission targets, and the security of oil supplies could also pose problems.

Technological change and innovation is likely to have a major impact on almost every facet of transportation in the coming decades. The impact of such change on the sustainability of transportation is difficult to predict, in part because the policy environment that will shape such change is uncertain. Technological change impacting upon transportation can take many forms. It can contribute to the extent to which non-transport alternatives can meet accessibility objectives through such alternatives as telecommuting for work, Internet shopping, tele-education and tele/video conferencing. It can change the design and operational characteristics of transport vehicles, how vehicles are used and maintained, and it can also offer new possibilities for traffic management.

Major changes in the design and operational characteristics of the motor vehicle could stem from:

- The use of alternative fuels;
- New types of internal combustion engines;
- The development of electric and hybrid vehicles;
- The use of advanced materials in body construction and enhanced streamlining of vehicles;
- The extensive use of light-weight materials in suspension and other components;
- Major re-design of seats and other components to reduce weight;
- The introduction of advanced transmissions and new types of tyres;
- New applications for electronics embodied in vehicles; and

- The development of on-board diagnostic systems to monitor vehicle performance and indicate the need for maintenance.

New technologies are also being developed for transit vehicles, particularly guideway vehicles, and alternative urban freight systems. Other areas that are the focus of innovation include transport logistics, electronic road pricing, and intelligent vehicle-highway systems.

The technologies that are likely to play the biggest role so far as sustainable transportation is concerned are the development of electric and hybrid vehicles, intelligent vehicle-highway systems, new types of transit vehicles, alternative urban freight distribution systems, and transport logistics.

There are many uncertainties about the future influences on urban transportation. The demand for travel could be affected by unexpected fluctuations in economic growth, or unanticipated changes in community preferences. Future research may change our perceptions of the environmental threats associated with transportation. Technological change impacting on transportation may be unexpectedly slow or fast. Policies may be either very slow or very quick to react to changing circumstances.

2.3 Policies for Sustainability

New policies are needed to achieve reduced emissions of carbon dioxide from transport, to overcome problems with air pollution, to increase safety and ensure wider access to transport services. There is no single solution to these problems. Policy actions are required on several broad fronts:

- The integration of urban planning with transport planning;
- Giving priority to transit in the development of transport infrastructure;
- The introduction of reforms to transit services;
- Strengthening transport management policies;
- Encouraging the development of sustainable new technologies over the whole range of transport service provision; and
- Utilising taxes as a means of shaping transport demand, encouraging the adoption of sustainable technologies, and providing a means of indirectly financing new transport infrastructure.

The interaction between the different areas of policy is the key to achieving sustainable transportation systems. The policies should be developed with the involvement of all stakeholders using foresight methodologies. They should be adopted in the context of clearly-articulated goals for sustainable transport and a framework for evaluating policy options and the progress of adopted policies in the context of sustainability goals.

The Integration of Urban Land Planning with Transport Planning

The integration of urban land planning with transport planning is a vitally important aspect of ensuring broad accessibility to employment and services for all groups in a city. It can also reduce the amount of travel required in a community and encourage an efficient utilisation of transport infrastructure. Key aspects of the required policies are:

- Encouraging higher urban density and mixed-use development in high income cities;
- Improving the scope for walking and cycling to achieve mobility requirements;
- Integrating land use planning with the development of transit infrastructure;
- Managing parking supply; and
- Providing for efficient distribution systems in urban planning.

Singapore, Hong Kong and Tokyo provide examples of successful integrated planning. Implementation of integrated urban planning in other major APEC cities has proved to be quite difficult in practice. In the United States, controlling urban sprawl and the redevelopment of inner cities is a high priority. However, the existence of numerous individual local governments boundaries with conflicting agendas within metropolitan boundaries, the absence of regional policy initiatives from state governments and the spillover of metropolitan areas across state boundaries has impeded progress in developing integrated planning strategies for metropolitan areas. Neighbouring Canada has achieved more success than its neighbour in developing regional urban planning.

In the third world, economic and demographic growth has tended to produce significant problems of traffic congestion, local air pollution and poor accessibility for lower income groups in the population. Key planning priorities are to control development in the urban perimeter, the upgrading of existing informal settlements, discouraging land speculation and decentralising development. Such policies are not easy to design and are particularly difficult to administer. In economies like the Philippines and Thailand, where primate cities (Metro Manila and Bangkok) have held dominant positions during post-war economic development, it is acknowledged that decentralisation policies need to look beyond the surrounding areas to the primate cities and provide encouragement to development in other regions of the national economies.

Developing Transport Infrastructure

It is desirable to assess all transport infrastructure proposals on a consistent basis that takes into account their economic, social and environmental impacts. Such assessments should view transport from an intermodal perspective, taking into account the interrelationship between road traffic and infrastructure, public transport, facilities for non-motorised modes and travel demand management. An important issue is to fully recognise the net social returns from infrastructure investments. The development of transit infrastructure is especially important in the major cities of the developing world.

Singapore, Hong Kong and Tokyo provide examples of successful transit infrastructure development strategies. Bangkok is in the process of planning or constructing massive transit projects. Significant developments in transit infrastructure have occurred or are planned in several major Australian cities. There has also been significant development in transit infrastructure in the major Canadian cities. There are only a relatively few examples of recently successful transit developments in the United States.

Public Transport Reforms

Improvements in the competitiveness and flexibility of transit services² can make an important contribution to the environmental sustainability of transportation and, by increasing the degree of substitutability between transit and private vehicles as a means of transportation, enhance the effectiveness of demand management and pricing strategies to contribute to sustainability. Transit services can be enhanced by the harnessing of new technologies, the extension of services coverage, capacity and frequency, improving operational flexibility, and increasing intermodality with different forms of transit and with private transport. Transit services within metropolitan areas should be regulated by a single authority that has no transport operational responsibilities. Privatisation or corporatisation of transit service operators may yield significant efficiency gains.

Tokyo's rail services are a model for the efficient operation of mass transit services. They provide frequency, predictability, reliability and safety to world-best standards. Mexico City has developed a many-tiered system of transit, with the mass transit Metro, intermediate carriers (light rail, electric trolley buses and suburban diesel buses), and a big range of paratransit feeder services. The

² Transit services include the following categories: rapid rail or mass transit; commuter or interurban rail; streetcars or tramways; buses; and paratransit (vans, jitneys, shuttles, minibuses and minibuses).

development and application of new smart paratransit technologies and services offers huge scope for servicing low-density suburbs in the advanced economies, but also for servicing the otherwise less accessible areas of developing country megacities.

Transport Management

Traffic management techniques are capable of reducing traffic congestion, increasing the effective utilisation of highway capacity, and reducing emissions. Singapore has been a leader in this area of policy. New technologies, such as advanced traffic simulators and intelligent vehicle-highway systems, offer considerable scope for improving the efficiency of traffic management. In inner-city areas, parking controls, restricted access, access tolls and traffic calming can be employed. Again, Singapore is the leader in developing such policies. Transport logistics has an important role to play in improving the efficiency of freight movements. New technologies now offer the possibility of utilising road pricing as a comprehensive technique for traffic management and rationing road space.

Technology Development Policies

Provided it is part of a broader menu of policies including active demand management policies, technology development policies can make a big contribution to reducing transport emissions. The OECD analysis suggests a policy of encouragement is necessary if timely contributions to transport sustainability are to be made by new technologies.

Cooperative research programs involving the public sector and companies, as occurring in the United States, will have an important role to play in developing base technologies. The potential for developing a new range of energy-efficient vehicles is high if sufficient research commitments are made. Public support may also be needed in developing an infrastructure to support energy-efficient vehicles. Inducements to secure private sector investments in new technologies may be necessary. The Californian mandatory targets for zero-emission vehicles are an example of such incentives. It is also important that encouragement is given to the swift spread of appropriate technological development to the developing economies. The scope for new technologies aimed at improving the characteristics of paratransit vehicles has big implications for transportation in the major urban centers of developing economies.

The Fiscal Issues

Taxes have an important role in shaping transport demand and encouraging the adoption of more sustainable technologies in transportation. Vehicle ownership and acquisition taxes have been aggressively used to control car ownership in Singapore. Fuel taxes can impact directly on transport demand and technology development. Increased fuel taxes will have a greater impact on sustainability if accompanied by improvements in transit services that increase the potential for intermodal substitution. Several countries have investigated taxing vehicles with high fuel consumption or emissions at relatively high rates compared with other vehicles and introducing rebates for purchasing vehicles with low fuel consumption or emissions.

These and other taxes aimed at transportation provide the fiscal means for funding sustainable transport infrastructure and other sustainable transportation projects. The revenues generated could be of major importance for developing sustainable transportation projects.

The Impact of Policies

The adoption of comprehensive sustainable transportation strategies can have a big impact on cities. The transformation of Hong Kong, China and Singapore from third-world cities some three decades ago to international benchmarks for sustainable transportation owes much to the policies pursued in those cities, particularly the integration of urban planning and transport planning, the development of transit infrastructure and the attention given to traffic management.

Research undertaken by the Transportation Research Board in the United States on the impact of various policies on carbon dioxide emissions from road vehicles indicates that, by the year 2020, the biggest impact on emissions would come from the adoption of higher fuel taxes, with improved urban planning and travel demand measures on the one hand and the introduction of new vehicle technologies on the other having smaller impacts. By the year 2040, the impacts of both higher fuel taxes and new technologies would be very considerable, leading to a marked reduction in aggregate emissions. The simulations did not allow for impacts associated with an increased development of transit services. What is important to note is that a combination of policies will have a deep impact by dealing with induced traffic associated with the adoption of single measures in isolation. Furthermore, most of the policies will take considerable time to have a major effect. Urban form can change only slowly over short periods of time, and technology development has a significant gestation period. Even taxes have a far bigger effect over a number of years than in the months following their introduction.

Social impacts are expected to be positive as a result of increased traffic safety and the provision of a wider range of transport services available to lower-income groups. However, a lot depends on how the tax revenues generated by the sustainable transport policies are utilised. Higher transport charges may need to be offset by tax reductions for the lower-income groups. There is also a danger that urban restructuring integrated with improved transit services may push up the prices of housing in the restructured areas, pricing poorer people out of the most accessible sites. Hence, specific social policy interventions may be required, such as the adoption of transport concessions for poorer people.

So far as the economic impacts of sustainable transportation policies are concerned, the important point to note is that government will collect higher taxes or use-charges for transport. This will allow increased government finance of infrastructure improvements and other sustainable projects and, possibly, reductions in other taxes. Companies will face higher charges for transportation but less traffic congestion, fewer accidents, and improved transport services. Consumers will pay more for transport, but enjoy safer, higher-quality transport services. The impact on aggregate economic activity is expected to be small, but positive.

The Implementation of Policies

Integrated policy-making for transport remains hampered to a large extent by fragmentation of policy responsibility both horizontally (across transport, environment, energy, finance and industry ministries) and vertically (across central, regional and local governments). Moreover, in many countries, municipal administrations are underbounded - substantial parts of the metropolitan areas are outside the boundaries of the central city jurisdiction.

The diffusion of information about sustainability to individuals within the cities is of vital importance in building support for sustainability policies. Education to broaden environmental literacy should be a key aspect of an overall strategy for sustainable transport. Finally, evaluation of policies and plans is important to test the usefulness of different approaches over time and against alternatives.

3. Implications for Sustainable Transport in the APEC Region

3.1 The Diversity of Experience within APEC

There is a great diversity within the major metropolitan areas of APEC. Per capita income levels, size, and the historical evolution of the urban form and transportation infrastructure vary enormously. As a result, the environmental and social pressures resulting from traffic movements also differ between cities. Prospective trends in transport demand also vary widely, with some metropolitan areas facing the prospect of stable populations and limited incomes growth, while others face rapid growth in both population and per capita incomes. The political and administrative framework within which urban planning, infrastructure development, traffic management and public transport services will evolve also differs from city to city. A variety of solutions to transport problems, whether involving choice in technology or the detail of policies, can be expected.

Despite this diversity, there is much to be learned from the experience of others. The APEC region includes around half of the world's major metropolitan areas. Each city has something to offer others in terms of lessons from its past and its plans for the future. A process of interactive research and discussion has benefits for all. Singapore, Hong Kong and Tokyo have been the most successful APEC cities in integrating urban land and transport planning, although Ottawa and Vancouver have achieved some successes. The same three cities - Singapore, Hong Kong and Tokyo - have provided models for the development of transit infrastructure, although there are a wide variety of interesting developments in the cities of North America and Australia. Tokyo's rail services provide a model for the efficient operation of mass transit services. Mexico City has an interesting mix of mass transit, intermediate light rail and diesel bus carriers, and a big range of paratransit feeder services. Singapore is the leader in transport management. Californian targets for low-emission vehicles provide a considerable incentive to technological development. The public-private Partnership for a New Generation of Vehicles is an example of government encouragement to sustainable research and development. Vehicle ownership and acquisition taxes are used to control car ownership in Singapore. Fuel taxes and parking taxes discourage the demand for car trips in Tokyo.

3.2 An International Approach to Sustainable Transportation Policies

International action to achieve sustainable transportation can be considered under four headings. In each case, there is considerable scope for actions to be taken within the context of APEC forums.

Regulation

The main policies advocated are the adoption of internationally agreed standards for air quality, motor vehicle emissions and fuel economy; the further development of protocols in relation to global warming; and coordinated action on fiscal and pricing mechanisms for restraining transport demand.

Technological Development and Innovation

It is important to address technological issues specifically connected with the needs of cities in the developing economies. A program of international collaboration in the development of technologies in such areas as low-emission motorcycles, low-cost and low-emission passenger cars and minibuses, and low-emission paratransit vehicles is recommended. There is scope, too, for the utilisation of foresight methodologies in developing a climate favourable towards the development of sustainable technologies.

Policy Evaluation Frameworks

A program of technical assistance, under the auspices of APEC and in conjunction perhaps with the Asian Development Bank and the World Bank, as well as the Overseas Economic Cooperation Fund of Japan, should be launched that would enable major APEC cities to adopt sustainable transportation policy frameworks. These frameworks should reflect the aspiration of particular cities while enabling international benchmarking of specific outcomes.

Inter-City Exchanges

Inter-city exchanges that focus on issues of urban and transport planning could yield substantial results in terms of increasing the range of policy options in dealing with sustainability problems, as well as providing a framework for sharing information on the experiences gained in attempting to implement sustainable transportation policies.

3.3 A New Paradigm in Urban Transport

This report, and many others, points to the need for a new paradigm in urban transport. The increasing urbanisation, particularly in the APEC region, is creating huge challenges for the existing infrastructure and current approaches such as building more freeways do not offer long-term viable solutions. While there is substantial room, and need, for continuing incremental improvements, they alone will not be sufficient.

Rather, approaches need to be based on the recognition that urban transport by private motor vehicles produces enormous social and economic disbenefits and that a more realistic costing needs to be introduced to change behavior. The study has highlighted the need for reprioritisation towards public transport, land planning use linked to transport planning to move away from low-density sprawl and the development of alternative growth centers as the three significant areas for attention by government at all levels. As in the case of the earlier technology foresight study on Water Supply and Management in the APEC Region, policy issues are identified as the more significant ones and technologies are seen to be the means to assist in achieving desirable outcomes.

4. Conclusion

In the absence of policy intervention, the increased demand for transportation is likely to give rise to significant environmental problems and will also exacerbate social and economic problems. The policies needed to achieve sustainable transportation include the integration of urban planning with transport planning, giving priority to transit in the development of transport infrastructure, the introduction of reforms to the operation of transit services, strengthening transport management policies, encouraging the development of new sustainable technologies over the whole range of transportation, and utilising taxes to shape transport demand and encourage the adoption of sustainable systems. The adoption of an international approach to sustainable transportation policies is desirable, with scope for international cooperation in such areas as regulation, technological development and innovation, policy evaluation frameworks, and inter-city exchanges.