REDUCING GREENHOUSE GAS EMISSIONS BY SHIFTING PASSENGER TRIPS TO LESS POLLUTING MODES

A BACKGROUND PAPER FOR THE BRAINSTORMING SESSION ON NON-TECHNOLOGY OPTIONS FOR ENGINEERING MODAL SHIFTS IN CITY TRANSPORT SYSTEMS

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EXECUTIVE SUMMARY

While to date the bulk of GEF project support for the transport sector has been directed at hydrogen fuel cell bus demonstration projects, the greenhouse gas (GHG) emission reduction benefits of these projects are likely to be long term. In the meanwhile, a host of municipalities, generally with the support of development institutions, have pioneered a host of measures that can reduce or slow the growth of GHG emissions from the transport sector in the short and medium term. All of these measures reduce GHG emissions by reducing the number of trips that people take by less energy efficient modes like private motor vehicles and taxis. These measures can be grouped under the label of Bus Rapid Transit (BRT), Traffic Demand Management (TDM), and Non-Motorized Transport (NMT). Implemented well, and simultaneously, these measures have proven to significantly reduce GHG emissions not only compared to projected growth in the sector but in real terms.

While BRT, NMT, and TDM projects have received financing from development bank lending, they tend to be neglected precisely because they are low cost and need not involve expensive international procurement. The GEF could thus play a critical project development role, leveraging funds for such projects, while supporting activities critical to achieving the public support necessary for actual implementation. It could provide this support in a way that helps to build public awareness and build the indigenous capacity for future planning and implementation.

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I. BACKGROUND ON TRANSPORT AND CLIMATE CHANGE

Transport continues to be the fastest growing sector of greenhouse gas emissions globally, and yet it is also the sector where the least progress has been made in addressing cost-effective reductions. None of the over 150 AIJ projects under the UNFCCC were transport related. Transport was also the last of the major sectors considered under the GEF, and most GEF projects in the sector are only now underway.

According to the International Energy Agency,

> "Over the next 20 years, global energy demand growth in transport will be greater than in all other end-use sectors, with it's share of total energy use increasing from 28% in 1997 to 31% in 2020[1]. These trends extend beyond the OECD; the IEA projects that growth in oil use and greenhouse gas (GHG) emissions from developing countries will far outstrip that from the developed world over the next 20 years. Oil use in transport is expected to grow three times faster in developing countries than in the OECD" (IEA, 2002).

The growth in motor vehicle use will simply overwhelm any efficiency gains from new fuels and technologies. Much of the growth in motor vehicle use will take place in the developing world. While petrol use in industrialized countries is growing by 1% per year, it is growing by 6% in Africa, Asia and Latin America. From 1995 to 2020, worldwide vehicle ownership is expected to grow by 75% to over 1.3 billion vehicles (OECD, 1995), with the greatest rate of growth to occur in Latin America and Asia.

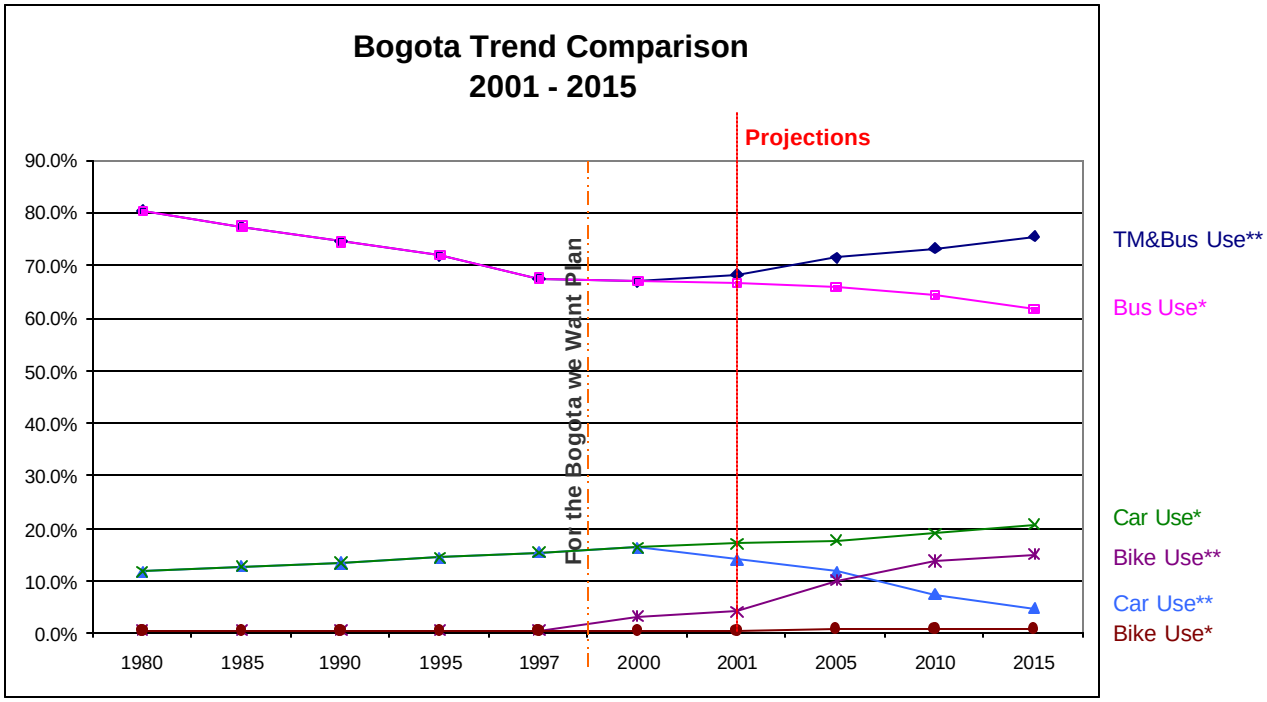
Ironically, developing nations currently possess modal shares of public transit and non-motorized transport that most OECD country planners would dream of possessing. Unfortunately, the quality of travel by these modes is often quite poor, which leads passengers to switch to two-wheel and four-wheel motor vehicles as soon as they can afford it. However, this trend is not preordained. There exist many cost-effective mechanisms to improve the quality of public transit and non-motorized options in developing countries, and thus retain and even expand modal share for these options.

Public transit in many countries continues to gain riders, and even in the United States public transit ridership is increasing rather than decreasing. However, even in these cities where transit ridership is increasing, public transport is still losing mode share, because private motor vehicle use is increasing faster. In other cities, public transit is actually losing riders. The World Business Council for Sustainable Mobility's *Mobility 2001* Report takes this as evidence that the observed tendency for public transit trips to continue to lose modal share is inevitable.

There are, however, a small number of cities where public transit is not losing mode share. These cities share a common characteristic: they have implemented Bus Rapid Transit systems (BRT), usually complemented with Traffic Demand Management Measures (TDM), measures to improve conditions for non-motorized travel (NMT), and land use measures.

[1] IEA World Energy Outlook 2000 forecasts 2.4% p.a. growth over this period.

BRT is the most advanced form of a family of measures that give priority to public transit vehicles in the traffic system. TDM refers to a family of measures that actually reduce the total number of trips by private motor vehicle, such as parking restrictions, traffic cells, and cordon or area pricing. Land use measures affect the location of new development and push it to more transit and non-motorized transport-friendly locations, either through land use regulation or



*** JICA Transportation Master Plan projections before the Plan "For the Bogotá we want"**
**** Projections based on the JICA, Steer Davies and City Hall studies after the Plan "For the Bogotá we want"**

Estimated Greenhouse Gas Emission Impacts of Bogota's BRT, TDM, and NMT Measures

The City of Bogota implemented all three of the measures that will be discussed below: BRT, TDM, and NMT improvements. At the time for which data was available, Bogota had only opened two lines of a planned 22 corridor BRT system. It had also build 200km of a planned 300km of bike lanes. They also expanded numerous sidewalks, added 1100 new parks, shaded promenades, and a 17 kilometer pedestrian zone, the longest in the world. They also implemented a number of TDM measures. Cars with license plates ending with one of four numbers are not allowed to operate within Bogota during the morning and evening peak, restricting access to 38% of the private vehicle fleet. Parking fees were increased by 100%, gasoline taxes were increased 20%, and bollards preventing people from parking illegally on the sidewalk were constructed. All these measures were promoted by a full car free day, car free Sundays, and other promotional efforts.

The effect of these measures on modal split over a 4 year period has already been impressive. The percentage of trips made by private cars and taxis dropped from 19.7% to 17.5%. Public transit passenger trips rose from 67% to 68% of total trips. Bike trips increased from 0.5% of trips to 4% of trips, a remarkable increase in four years. In 2001, the combined BRT, TDM, and NMT measures resulted in a reduction of CO_2 emissions by 318 metric tons per day from 1997 levels in absolute terms. Roughly 90% of this resulted in the modal shift from private car and taxi to bus and bicycle, and 10% from efficiency gains within the public transit system. If the CO_2 emission benefit is measured against the JICA - projected modal split for 2001, the benefits of the combined measures per day is 694 metric tons of CO_2. The projected benefits per day of the change in modal split will rise to 5688 metric tons per day by 2015 if the projected impacts of the current plans are realized. (Compiled by Oscar Edmundo Diaz)

through the strategic location of public spending for low income housing, environmental clean up, or land preparation.

Table 1 Changes over time in daily average public transport trips, selected cities (includes bus, rail and paratransit)

	Earlier Year				Later Year			
City	**Year**	**Population (million)**	**Pubic Transport Trips/day**	**Percent of All Trips**	**Year**	**Population (million)**	**Pubic Transport Trips/day**	**Percent of All Trips**
Mexico	1984	17.0	0.9	80	1994	22.0	1.2	72
Moscow	1990	8.6	2.8	87	1997	8.6	2.8	83
Santiago	1977	4.1	1.0	70	1991	5.5	0.9	56
Sao Paolo	1977	10.3	1.0	46	1997	16.8	0.6	33
Seoul	1970	5.5		67	1992	11.0	1.5	61
Shanghai	1986	13.0	0.4	24	1995	15.6	0.3	15
Warsaw	1987	1.6	1.3	80	1998	1.6	1.2	53

Source: WBCSD, 2001

The erosion of public transit's mode share points to how we should view emission baselines and measure success. While the Bogota case above indicates that reverses in mode split are possible, simply retaining existing transit and non-motorized customers in the developing world will realize large emission savings. Focusing upon tailpipe-only solutions, while a part of the package, have proven to be expensive per dollar of CO2 reduction. The low-tech nature of many rider retention initiatives makes them more cost effective when implemented with sufficient political will. While modal shift strategies are viable under current GEF criteria, achieving GHG emission reductions against baseline projections will be much easier than absolute reductions precisely because most major cities are consistently losing 0.3-1.2% of public transit mode share each year.

For quantifying the greenhouse gas emissions impacts of a shift in passenger trips between modes, it is useful to have a common evaluation measure. Table 2 provides emissions per passenger – kilometres for a range of modes. The values are derived from a variety of sources (Sperling, Dan, University of California at Davis; UK Dept. of Environment; European Commission), and are intended to provide a relative comparison for discussion purposes. A more rigorous definition of emission factors would need to include analysis of actual driving practices, vehicle models, local traffic conditions, local fuel types, and vehicle maintenance practices.

Table 2 Greenhouse gas emissions by mode

Mode	CO2-equivalent emissions (grams / vehicle-km)	Max. capacity (passen.)	Ave. capacity (passen.)	CO2-equivalent emissions (grams / passenger – km)
Pedestrian	0	1	1	0
Bicycle	0	2	1.1	0
Gasoline motor scooter (2-stroke)	118	2	1.2	98
Gasoline motor scooter (4-stroke)	70	2	1.2	64
Gasoline car	293	5	1.2	244
Gasoline taxi car	293	5	0.5	586
Diesel car	172	1.2	1.2	143
Diesel minibus	750	20	15	50
Diesel bus	963	80	65	15
CNG bus	1050	80	65	16
Diesel articulated bus	1000	160	130	7

This rough analysis shows the significant emission benefits to be gained from retaining mode share with both non-motorized and public transit options. Assuming an urban commuter travels a total of 4800 kilometers per year (20 kilometers per work day in a 240 day work year), the average commuter will contribute: 470 kilograms of CO2-equivalent traveling by a two-stroke motor scooter; and 1170 kilograms of CO2-equivalent traveling by car. By comparison, a commuter traveling in an articulated Euro II diesel bus, such as those utilized in Bogota's TransMilenio system, will contribute only 34 kilograms of CO2-equivalent. It is worthwhile to note that the emission reductions difference between bus propulsion technologies (diesel, CNG, hybrid-electric, fuel cell) can easily be dwarfed by the substantial gains made from mode share retention or mode switching.

II. BACKGROUND ON GEF INVOLVEMENT IN THE TRANSPORT SECTOR

The Global Environmental Facility was for many years reluctant to become involved in the transport sector, fearing that the cost of interventions would inhibit a productive role for the GEF, and fearing the Greenhouse Gas Emissions impacts of transport sector projects would be difficult to quantify. In the late 1990s, after the STAP issued a set of recommendations, the GEF Council produced OP #11. OP #11 prioritized the following projects:

a. Modal shifts toward more efficient and less polluting forms of public and freight transport through measures such as traffic management and avoidance and increased use of cleaner fuels

b. Non-Motorized transport
c. Fuel cell or battery operated 2 – and 3 – wheelers designed to carry more than one person
d. Hydrogen powered fuel cell or battery operated vehicles for public transport and goods delivery
e. Internal-combustion-engine/electric hybrid buses and
f. Advanced technologies for converting biomass feedstock to liquid fuels.

Before the passage of OP #11, the GEF funded a transport project in Tehran that focused on setting up the initial emissions monitoring systems, inventories of sources, and proposed further interventions, but it basically funded studies. A second project, approved in 1996, was a $7 million project in Pakistan, focused on setting up vehicle inspection and maintenance centers. The energy-efficiency gains of better vehicle maintenance can be significant, but no evaluation of this program was publicly available.

With the passage of OP #11, several other major GEF transport projects were approved. Most were hydrogen-fuel cell bus technology projects. India, China, Mexico, Brazil, and Egypt all have hydrogen fuel cell bus pilot projects in the early implementation stage, with the first buses being delivered soon. Such projects have consumed most of the resources allocated under OP #11, mainly for the purchase of vehicle prototypes.

However, it is becoming increasingly clear that the transport sector GHG problem cannot be solved by vehicle technology interventions alone. In June of 2000, the GEF, UNEP, and UNDP sponsored a major conference on the *Commercialization of Fuel Cell Buses: Potential Roles for the GEF*. This forum concluded the following:

> "To be successful, fuel cell bus demonstrations need to be part of an overall integrated strategy, including planning, alternative technologies, improved traffic management (e.g. dedicated bus lanes), to reduce local air pollution, reduce congestion and reduce greenhouse gas emissions in urban centers."

While those cities where fuel cell bus demonstrations have been initiated would certainly benefit from a broader approach, new projects focusing on encouraging a shift in passenger trips toward more sustainable modes should not necessarily focus on the same cities, as the selection criteria for such projects is different. The recommended selection criteria are sketched out in Section VIII. Those governments that have readily accepted the fuel cell bus demonstration projects tend to be countries with large domestic bus manufacturing, and they are interested in using the projects to help develop their own motor vehicle industries. By contrast, many countries most likely to embrace projects encouraging modal shift may have little indigenous motor vehicle manufacturing. Using selection criteria designed for a fuel cell bus project may doom a modal shift project to failure.

The NGO and technical community have raised several concerns about the emphasis on fuel cell buses as an effective means of reducing transport sector GHG emissions in the short term. The first concern is that fuel efficiency is not only a function of engine technology but also a function of roadway congestion. Hydrogen fuel cells will do little to reduce GHG emissions if trapped in congestion. Nor will simply building more roads solve the problem. An ever-

growing number of studies, most notably the British SACTRA Report, show that building more roads only induces more traffic, and hence cannot reduce GHG emissions.

Secondly, GHG emissions per person are also a function of the mode people take to make a trip. Even if the buses generate no GHG pollution, if the buses are too expensive for people to use, passengers will switch to more polluting modes. The price elasticity of demand for public transit varies with circumstances, but can be quite high. In the medium term, it is going to be difficult to commercially introduce hydrogen fuel cell buses without increasing public transit fares. If the fares increase, this will shift some passengers to more GHG-intensive modes like private cars and taxis, mitigating the benefits of the new technology.

Third, the politics of bus procurement in developing countries is extremely complex. Even if a cost competitive, pollution-free hydrogen fuel cell bus were available, (which is unlikely before 2010) there is no guarantee that public or private fleet operators would purchase them. Political influence rather than market rationality is endemic in the sector.

Finally, the full-cycle GHG emission reductions from fuel cell vehicles are much debated and depend on the fuel source. There are a host of complex issues that need to be overcome before a supply of low GHG hydrogen fuel can be secured.

As the GHG emissions benefits from these projects are limited in the near term, and commercial viability is uncertain in the medium term, the GEF should explore supporting other projects that can achieve nearer-term and more easily demonstrated GHG emission reductions. Furthermore, projects which have clear secondary benefits, such as poverty alleviation or public health improvement, should be encouraged, so that even if the GHG impacts are not fully realized, the projects can be partially justified by their secondary impacts.

The GEF has some experience with the promotion of Non-Motorized Transport. The first was for Marakina, Manila, the Philippines, and the second for Gdansk, Poland. These two projects are also in the reasonably early implementation stage. The Marakina project was about $1.27 million for pilot bikeways and bike promotion in a District of Manila relatively sympathetic to bikes that already had some bikeways.

Most recently, new GEF projects approved for Santiago and Lima, designed in conjunction with World Bank urban transport loans, have a greater focus on modal-shift-oriented measures. While the final details of these project are yet to be fully worked out, the Lima and Santiago projects will most likely include the preparation of plans for a bus rapid transit system, build on earlier efforts to improve bicycling and pedestrian facilities, and support promotion of these less polluting modes. These newer projects are most notable in their careful coordination with the activities of other institutional actors involved in the sector, primarily the World Bank and the Inter-American Development Bank.

Achieving modal shift in transport projects is, like commercializing hydrogen fuel cells, difficult and complicated. But some notable successes in recent years indicate that such projects could yield GHG emission reductions in a much shorter time frame than other approaches, and hence are worth exploring.

Maximizing the efficacy of GEF funds used for encouraging modal shift requires even more than in other sectors a determined effort to strategically compliment and build on the numerous efforts being made by other institutions active in the field, most notably the World Bank, the regional development banks, the private sector-lending arm of these banks, the bi-lateral aid and export credit agencies, the technical assistance available from the international programs of national environmental and transport agencies, private foundations, and not least of all NGOs who bring their own resources. The complexity of the transport-sector problems, and the number of institutions involved should not, however, be a deterrent to developing an effective program to address this critical issue.

III. BUS PRIORITIZATION AND BUS RAPID TRANSIT

III.1. BRT Measures

When most municipal officials decide to *do something* about declining public transit use and worsening traffic congestion, many of them decide to build extremely expensive rail-based metro, MRT, or light rail systems. While these systems have some advantages, and under certain conditions may marginally slow the decline in public transit ridership, there is little evidence that such investments into rail-based systems have actually reversed the decline in transit mode share. This is generally because such systems are too expensive to substantially improve conditions for the majority of public transit passengers, and almost inevitably lead to an actual decline in public transit system investments for the majority of transit passengers.

The only public transit improvements that have succeeded in both increasing public transit mode share and reducing private motor vehicle mode share **have been** Bus Rapid Transit **systems.**

The primary characteristics of BRT systems include:

- Segregated busways
- Rapid boarding and alighting
- Clean, secure and comfortable stations and terminals
- Efficient pre-board fare collection
- Clear and prominent signage and real-time information displays
- Transit prioritisation at intersections
- Modal integration at stations and terminals
- Clean bus technologies
- Sophisticated marketing identity
- Excellence in customer service

BRT systems evolved by emulating many of the characteristics which give metro systems high passenger capacity and travel speeds, but in a way which minimizes their cost. Metro systems are much faster than buses mainly because a) they are not stuck in traffic, b)they don't have to stop at traffic lights, and c) passengers enter many large doors simultaneously rather than

filing in a small door one by one. The relative importance of these measures varies from system to system and within systems. Because metro systems are higher status, it is also believed they will be able to more successfully compete for higher income passengers who otherwise would be more likely to commute by private car or taxi. Thus, the appearance and comfort of the station and the vehicles tends to be of higher quality than ordinary buses.

By operating on an exclusive right of way, they will not be caught in congestion. This right of way can be taken from an existing roadway, can be built in a median, or can be built on an elevated structure. Taking existing road space is the least expensive but generally requires great political will. Constructing as part of new road construction or in an existing unutilized median tends to be easier politically, though more expensive. New elevated structures have been used for certain limited sections on some systems but are very expensive. Some systems only fully segregate the right of way where there are significant bottlenecks, such as at bridges and along congested arterials.

The rapid boarding and alighting is generally made possible by several related features. First, passengers tend to pre-pay when they enter an enclosed station area, such as the well-known pre-boarding tubes used in Curitiba. These structures are relatively inexpensive, costing only around $35,000 per station in some cases. Once in the station, as passengers have already paid, they can enter and exist the buses when they arrive through all doors simultaneously. The selection of the bus type to operate on the system therefore tends to favor buses with large wide doors. Finally, the platforms are on a level with the bus floor, either by having a high platform or a low floor bus. This allows elderly people, children in strollers, and people with packages and bicycles who often cause delay to get on and off much faster because they don't have to climb down stairs. This obviously works best with buses specifically designed for this purpose, but even if standard buses are used many of the benefits can be achieved by prepayment and simultaneous use of multiple doors.

BRT systems also tend to have transponders that automatically change traffic signals to green upon their approach. Such transponders are also used in fast tram, light rail, and trolley systems in Europe. In congested urban areas with numerous intersections, this traffic signal prioritization can be as important as the dedicated lanes.

While these measures are not without cost, they cost as much as 1/50 of the price of a metro, with roughly the same operating characteristics. BRT systems have been built for as little as $1 million per kilometer, though $5 million per kilometer is more typical. Once constructed, and one the vehicles are purchased, they are fully self-financing at very low fares (generally under $0.50 per ride) and can move 35,000 passengers per hour per direction in a two-lane system.

III.2. Successful Examples of BRT Systems

While for years, the only successful example of a BRT system was in Curitiba, Brazil. Built in the 1970s, it is the only system for which long term data is available. Curitiba remained the only fully realized BRT until the late 1990s, though many elements of the Curitiba system existed in other systems. Europe had many exclusive busways and tram and bus signal

prioritization, but other features were missing. The lack of successful replication made many skeptics believe that, like the Singapore Area Licensing Scheme, the project could not easily be replicated. This all changed in the 1990s, with the opening of BRT systems in Kunming, Quito, Porto Alegre, Sao Paulo, Nagoya, Goiania, Pittsburg, Eugene, Rouen, Bristol, and a growing number of cities around the world.

Curitiba's BRT witnessed a modest increase in public transit's mode share when it initially opened, and was able to increase ridership by 2.36% a year for over two decades, enough to maintain the public transit mode share when every other Brazilian city was witnessing significant declines. (Rabinovitch & Hoehn, 1995) With the introduction of the TransMilenio BRT system in Bogota, public transit ridership increased from 67% to 68% when the system had only opened two out of 22 planned lines. (Municipality of Bogota, 2002)

BRT systems also reduce emissions by realizing efficiencies within the public transit system. Before the shift to BRT, many private operators were operating well under capacity, and because they were stuck in traffic they could only make a few trips per day at very low fuel efficiency. The BRT increases the ridership on the vehicles, and by removing congestion increases fuel economy. In Bogota more than10% of the GHG emission reductions were from these changes, and this share will increase as the coverage of the BRT system expands. The BRT system reduces the number of buses needed to serve the same number of passengers by 2.7.

Significant reductions are made not just with greenhouse gas emissions but the entire range of criteria pollutants (SOx, NOx, PM, CO). In the three corridors served by Bogota's new TransMilenio system, SO2 emissions were reduced by 40% and PM10 by 10% in the affected corridors.

III. 3. GEF and other International Institutional Involvement in BRT to Date

Thus far, the GEF's involvement in BRT promotion and implementation has been limited. Most promising is the planned GEF project for Lima. In Lima, the municipality has already invested billions of dollars into a surface metro system that has yet to become operational. It is badly planned, and has basically inhibited the ability of the municipal to make any other meaningful improvements in the public transit system. Taking advantage of government transition in Peru, and in the midst of negotiating a major urban transport sector loan, the World Bank was able to bring the dynamic former Mayor of Bogota to Lima to meet with and give presentations to the Mayor and other city leaders. The Municipality is now convinced that it needs to begin a BRT pilot project, and has requested GEF funds to initiate its planning. This has been approved by the GEF council. In Mexico City, the World Bank has also been negotiating a possible GEF project which would include a demonstration BRT, though negotiations are hampered by recent plans to construct a massive double-decker highway through the center of the city. In Santiago, the World Bank also has approval for a GEF transport project, but it is not yet certain if it will include a BRT, and Santiago has also announced plans to go ahead with the much-disputed Cosantera Norte highway. The NGO Ciudad Viva is present at this meeting and can provide details.

For the Bogota system, the municipality funded 90% of the system with municipal funds, but 10% came from the reallocation of a World Bank loan for general improvements in the corridor. The initial terms of reference under the World Bank loan were for a standard surface bus lane. Bogota's Mayor changed the terms of reference and hired Steer Davies and McKenzie consulting firms for the necessary technical assistance. Quito had some help from the Spanish foreign aid agency. Kunming was supported by a sister city project with Zurich and Swiss Agency for Development and Cooperation. Plans for a BRT in Surabaya were developed by GTZ.

IV. Traffic Demand Management (TDM)

The success of the BRT schemes in Bogota, Curitiba, and other cities was in part made possible by the simultaneous implementation of a number of TDM measures. Traffic Demand Management measures actually reduce the total number of trips by a particular mode (normally private motor vehicles). It is important to distinguish such measures from traffic management measures which are generally aimed at increasing the capacity of the existing road system, and tend to stimulate rather than suppress traffic. Assessing the separate impact of the BRT versus the TDM measure in this context is thus not easy. However, some countries have implemented only the TDM measures and provide some indications of their relative importance.

IV.1. Traffic Demand Management Measures

The main traffic demand management measures used by municipalities to control the total amount of motor vehicle traffic are congestion or cordon pricing, parking measures, and traffic cells. BRT, traffic calming, and pedestrianization can all be implemented in a way which suppresses traffic, but these measures are discussed separately.

Congestion pricing is the holy grail of traffic demand management measures, as it would, in theory, fully internalize the marginal social cost of operating a private motor vehicle into the individual's cost of making the trip. With new electronic road pricing technologies now available and in use in several cities, congestion pricing is fully technically possible. Cordon pricing, or area licensing, is a similar, low-technology mechanism for making drivers pay something for entering congested downtown areas. In these systems, drivers are charged for using specific roads, bridges, or zones, during congested periods. The charging mechanism may be ordinary toll collection, special licensing, or various electronic payment systems. While any of these simple forms of road pricing can simulate congestion pricing, the mechanism for setting charging rates remains perhaps inherently political and hence only by chance will actually reflect fully allocated marginal social cost of making a trip.

Parking regulation is another key mechanism for TDM. Simply restricting the total supply of available parking, through such measures as using bollards to prevent people from illegally parking on the sidewalk, can have a significant impact constraining traffic. Limiting or reducing the level of employee-provided or subsidized parking can have a significant impact on reducing private motor vehicle trips. State agencies and universities often provide free parking

for employees even in central cities on extremely valuable urban land. Tax laws often create incentives for employer-subsidized parking. When employees have to pay the full cost of parking, many more opt for taking public transit or cycling.

Parking pricing measures may or may not function as traffic demand management measures. Increasing parking charges in office areas may reduce private motor vehicle commuting trips, while increasing parking charges in commercial areas may increase traffic by encouraging turn-over of the parking space, or decrease it if the spaces are left open.

Parking cash-out schemes have proved to be an effective option for higher-income developing countries. Under such schemes, employees who choose not to utilize employer-subsidized parking will receive an equivalent amount in cash, transit vouchers, or even a bicycle.

Traffic cells are another interesting TDM measure. Traffic cells restrict the number of private motor vehicle trips into a congested area by making it impossible for private motorists intending only to pass through the area to go around, while allowing public transit passengers and cyclists to take the much more direct route through the center. This is generally done through the use of one-way streets and physical barriers.

Measures to improve conditions for pedestrians and cyclists also will tend to slow traffic and might be considered TDM measures, but they will be discussed under NMT measures in the following section.

IV. 2. Successful Examples of Implemented TDM Measures

IV.2.A. Area Licensing, Congestion Pricing

The most fully realized example of TDM is Singapore's Area Licensing Scheme (ALS), the world's foremost example of 'cordon-pricing'. Some 7.5 square kilometers of downtown Singapore were designated a 'Restricted Zone,' which, in order to enter during rush hour between 7:30 and 10:15 required a special daily or monthly license which could be purchased at post offices or kiosks outside the Restricted Area. Initially, buses, carpools of more than four passengers, and commercial vehicles were exempt, but in 1989 the restrictions were extended to trucks and carpools. The city built large gantries over the major roads indicating that drivers were entering the Restricted Zone. The license is a large, color coded sticker that is placed in the window of the vehicle. Two or three monitors then stand at each gantry and check to make sure that cars entering the Zone have the appropriate sticker. Violators are sent a ticket by mail. While this measure was implemented in conjunction with several other measures mentioned below, the area licensing scheme was a key reason why total vehicular traffic in the zone decreased by 50%, private car traffic decreased by 75%, and travel speeds downtown increased from around 18kph to 30kph.

London just decided to implement a cordon pricing scheme, which will give huge impetus to these measures. Hong Kong, Bangkok, and Jakarta, have all explored the possibilities but have not implemented them. Current discussions about tolling the East River Bridges in

New York City would create virtual cordon pricing for all of Manhattan Island. Historically, such measures have proven politically difficult, though not impossible, to implement. Most are now being sold as a mechanism for increasing commuter's options. Consumers wishing to enter a congested area can either use a congestion-free facility but carpool or pay a toll, or they can use a congested facility. This gives more consumer options than only having the choice to suffer through the congestion.

IV.2.B. Parking Measures

In Singapore, the congestion pricing measures were coupled with the doubling of parking charges on both public and private lots (through surcharges and mandated increases), and uniform hourly rates were replaced by rates which varied by geographical location and duration of stay. As the fees for a violation were nearly the cost of a monthly pass, the rate of violation was quite low, less than 2%. Bogota, Budapest, and Warsaw all implemented some impressive measures to prevent motor vehicles from parking on the sidewalks and increasing parking charges. These measures led to significant political controversy in each city. In Warsaw and Budapest, NGOs played a key role in overcoming popular resistance to the measures. In Bogota it was mainly the effort of the Mayor.

Mayor Bloomberg in New York has just cut parking spaces for public sector employees by 20%, with immediate traffic benefits. Parking cash-out may be another mechanism worth piloting in some selected cities.

The US now has several examples of parking cash out schemes. In the US State of Maryland, employers who encourage their employees not to utilize employee-subsidized parking by giving the equivalent amount of money in cash are given tax-credits per participating employee. The results to date suggest a phenomenal mode shift away from the private automobile of between 10-30% for participating companies. (Replogle, 2001).

IV.2.C. Traffic Cells

. Oxford, England, and the free-trade zone in Manaus, Brazil are two examples of using one-way streets to make it impossible to pass through an urban core in a private motor vehicle, dramatically reducing traffic in the center. Expert studies indicate that a majority of trips are not diverted to other roads, they are diverted to other modes, or they disappear. A city like Hyderabad, India, with a beautiful historical center falling to ruins due to traffic, noise, and pollution, would be an interesting pilot project if the backing of the Chief Minister can be secured.

IV.3. GEF and other Institutional Involvement in TDM

GEF involvement in TDM plans and projects to date has been minimal, but there may be some TDM elements in the Santiago and Lima projects. There have been a reasonable number of World Bank and EBRD urban transport loans that have included measures such as the construction of bollards to keep cars from parking on the sidewalks. The EBRD urban transport loan to Budapest included funds for bollards and paid meter parking. There were extensive

discussions between the World Bank and several municipalities about congestion pricing or road pricing projects in such cities as Bangkok and Jakarta, but nothing ever came of them, partially out of World Bank nervousness about how the funds would be used. There are often parking facilities constructed under World Bank loans, but as often as not these are new parking facilities that are as likely to induce traffic as manage demand. The World Bank loan to Guangzhou funded a study of TDM measures, and programmed funds for their implementation, but of the actual measures proposed only about half of them were actual TDM measures, and the others were traffic management measures which would have the reverse effect of increasing traffic.

Without a highly transparent process of public, NGO, and technical expert supervision, there is a significant risk that projects labeled "TDM" will in fact be merely traffic management measures, with no positive GHG emission impacts, and very possible adverse effects.

V. IMPROVING ACCESS

V.1. Land Use Measures

Access can be improved by affecting the location of employment, shopping, and housing in such a way that average trip distances and total trips can be reduced, and people can be encouraged to make these trips with more energy efficient modes. Both will reduce GHG emissions. Various mechanisms can be used to encourage the co-location of shopping, housing, daycare, and employment, and their location near public transit, cycling, or pedestrian facilities. These measures fall into two broad categories, regulatory measures and public investments.

Regulatory measures would include zoning laws restricting the construction of high rise buildings to areas near to high capacity public transit systems like BRTs or metros or major bus corridors, and the restriction of construction of new shopping and housing facilities to areas already within a certain distance of a public transit line. Public investment measures would include locating public facilities in transit-friendly or central locations, housing programs encouraging housing development near transit facilities, and the preparation of brownfields for redevelopment.

V.2. Successful Interventions to Improve Access

The success of the Curitiba BRT system was helped by a zoning system which allowed for high density development in the public transit corridor, but tightly restricted development in areas not served by the transit system. The Dutch ABC system also only allowed new developments in locations already served by public transit. In many developing and transitional countries, however, enforcement of land use restrictions has proven difficult. One hopeful example is the Kunming provincial development plan, developed in cooperation with the Swiss Agency for Development and Cooperation. In this rapidly urbanizing megacity, new urban development has been concentrated in growth corridors served by commuter rail lines. Curitiba, Singapore and Hong Kong all used land banking along transit corridors to help develop low-income housing in transit friendly locations. Washington DC relaxed zoning restrictions around

Metro stations with some effect, and Maryland's I270 growth corridor has also reduced some trip lengths. The methodology for modeling land use impacts on transport are still evolving, and most models are complex, data intensive, and proprietary.

In Central Europe, the existence of enormous tracts of old industrial land and decommissioned military bases in transit-accessible locations make some sort of state support for bringing these 'brownfields' up to a legal, environmental, and physical condition suitable for private developers is a key area where state involvement needs to be increased, though obviously such state involvement without careful public oversight could lead to any number of abuses of state power. New efforts by CzechInvest in this regard, with technical support from the US EPA, the APA, and the OECD are notable.

There are a few innovative new ideas with only a few pilot projects but promising enough to warrant mention. Chicago has experimented with location efficient mortgages, where homeowners willing to locate in transit-friendly locations are able to access lower interest mortgages on the theory that their not needing to buy a car will allow them to save more money.

Much has also been made of tradable development rights as a market-based mechanism for imposing new development controls on ecologically sensitive or auto-dependent land by giving the owners development rights in other, less sensitive locations. These programs have been tested in the US, such as in the Long Island Pine Barrens, but have not thus far caught on.

V.3. GEF and other Institutional Involvement in Promoting Access

The GEF has not to date been involved in these issues, though it may have been involved in other land protection issues in other sectors. The World Bank has been hostile in general to the notion of regulatory measures to control land use, fearing they will lead to market distortions and fail to meet access objectives. The World Bank has also been generally hostile towards the sort of state interventions in the housing or brownfield sectors that would encourage transit-sensitive development. The EBRD has helped redevelop some brownfields but generally in a way insensitive to generated traffic concerns.

There are a few cases of pro-active urban revitalization projects which might help re-orient new urban growth back to town centers. UNDP has worked on historical restoration of urban areas in some countries. The Fez, Morocco project of the World Bank provides some hope in this regard, providing support for low income housing and monument reconstruction in an effort to help attract tourism. Efforts to revitalize some downtown areas in Latin America, such as the efforts in Salvador and Manaus, Brazil, have been reasonably affective at creating a pedestrian-oriented tourism industry.

VI. NON-MOTORIZED TRANSPORT

There are three ways that governments and NGOs have intervened to increase the use of Non-motorized modes of transport (NMT):

1. NMT-oriented infrastructure to ensure safety and security
2. Improving NMT technology, affordability, and sustainable supply
3. Programs aimed at increasing the popularity of NMT to increase ridership

Some critics claim that bicycles are inherently backward and will eventually be phased out all over the world, and therefore feel that supporting bicycle use is hopeless. In fact, no such conclusion can be drawn from the data. Bicycle and walking trips are both rising and falling in both high and low income countries. High levels of bicycle use are observed in both high and low income countries. Bike use and walking, where prevalent, is not generally concentrated among the poor but spread among income groups. The only clear correlation is between higher bike *ownership* and higher income.

Ownership: The US has very high levels of bike ownership, with levels just under motor vehicle ownership rates. In Europe there are 200,000,000 bicycles, and only 160,000,000 cars, though the overall bike market for the whole EU has fallen from about 18 million units a year to 14 million units. Bike ownership levels in Japan are higher than motor vehicle ownership levels. Whether bike ownership or motor vehicle ownership levels are higher, most of the time the trend is for bike ownership and motor vehicle ownership levels to rise and fall together, contrary to misconceptions. In China, bicycle ownership grew constantly from the 1960s to 1992, rising most rapidly after the economic liberalizations of the early 1980s. Bike sales peaked in 1989 - 1992, reaching 40 million annually. Since 1998, domestic bike sales in China dropped sharply, falling to around 20 million today. In India bike sales continue to increase nationally but are falling in major cities like Delhi. In Africa, bike ownership has correlated closely with motor vehicle ownership, with both motorized and non-motorized vehicle fleets falling during the economic contraction of the mid-1980s to mid-1990s. Both began rising again in the mid-1990s.

Use: Reliable data on bike use is hard to come by. According to the Institute for Cycling Expertise in Utrecht, bike use in Amsterdam peaked around 1940 at 80% of total trips, fell to its lowest level, around 27% in 1975, and has risen since then back to around 37% of trips. Mode share patterns in Copenhagen have followed a parallel trend. From 1977 to 1995, bike use in the US increased from 0.5% of trips to 0.9% of trips nationals. In Germany, bike use increased from 7% to 12% over the same period. (Pucher and Dijkstra, 2000) In New York City, roughly 10,000 cyclists passed into the Central Business District during peak cycling weather, and in 2000 the number had risen to 14,000 (Transportation Alternatives, 2000): not an impressive number, but the trend is upward. Clearly, over the last two decades in these three most developed countries, bike use has been increasing rather than decreasing, and in Europe they represent a substantial mode share. This shift parallels in time exactly the beginning of de-industrialization, the second oil shock, and the shift to a post-industrial economy.

The most depressing case has been China, with Vietnam following the same trend. Bike mode share increased in Chinese cities until the early 1990s, when they accounted for from 30%

to 70% of all trips even in major cities. In the late 1990s, bike use fell sharply in Southern and Eastern provinces. In Guangzhou, bike use dropped from 36% in 1990 to only 15% of trips today. While wealthier residents have voluntarily upgraded to taxis, mopeds, or motorcycles, bicycle use has declined largely as the result of explicit public policies banning their use on major arterials, and the re-engineering of major urban arterials to higher speeds while systematically removing bicycle lanes.

Cycle rickshaws also do not follow entirely predicable patterns. There were no cycle rickshaws in use in developed Western Countries until the 1990s. In the 1990s, small fleets of cycle rickshaws spread to over 40 US Cities, and at least a dozen European cities, including very modern vehicles in Berlin. Their numbers are few, however, and do not constitute a significant share of trips. Three wheelers were unseen in Mexico City until recently, and they now operate in the Zocalo area. In many cities in Colombia three wheelers are gaining popularity despite being illegal. They are unheard of in Africa, but many cities are interested in them. In Asia, where they are the most prevalent, they were introduced into India and Indonesia and other Southeast Asian Countries mainly after World War II, primarily as an upgrade from the standard rickshaw. They were banned in Malaysia and Thailand in the 1960s, and in Jakarta and parts of Delhi in the 1980s and 1990s. Their use in Indonesia peaked in the mid-1980s, fell with repression and economic growth, and then re-emerged heavily with the economic crisis after 1997. In Manila they were heavily used in the 1950s and 1960s, banned in the 1970s, and re-introduced in certain areas in the 1990s. In India there numbers are roughly constant, estimated to be around 5 million nationally.

The walking data shows the most universal declines. While data on walking trips is of notoriously poor quality, walking as a share of trips seems to be declining in Western Europe and the US. The decline of walking trips is even more alarming in many developing countries. In Surabaya, Indonesia, where per capita incomes have fallen to around $400 a year, for trips under 3km, Surabaya is three times more dependent on motorized modes than Germany. A significant reason for this incredible dependence on motorized transport is serious severance problems created by a one-way traffic system, restrictions on bike and becak use on some critical arterials, the absence of controlled intersections, and the absence of even basic, unobstructed sidewalks. According to the GTZ calculations, if the modal split in Surabaya for trips under 3km could be brought to the same modal split for trips of the same length in Germany, an estimated 186 metric tons of CO2 would be reduced on a daily basis. (Improvements…, 2000, p. 28) The fall of walking trips has been greater than the increase in bicycling trips in almost all countries. This trend has alarmed public health experts, and been correlated to the rising incidence of obesity in both developed and developing countries, and correlated illnesses like cardiovascular illness and diabetes.

In conclusion, the data suggests that bikes and cycle rickshaws, rather than being inherently backward, are both legitimate forms of modernization up from walking and rickshaws. Their growth in developed countries indicates that they have their own modernization trajectory, and remain a viable and competitive means of addressing short distance trips if they are not forced off the streets by hostile government regulation and/or unsafe roadway designs.

VI. 1. Measures to Increase NMT Use

VI.1. A. Non-Motorized Transport Infrastructure Improvement

Before even designing and selecting NMT facilities, priority locations need to be selected. There are two basic approaches to selecting priority locations for new bicycle and pedestrian facilities, which should be utilized. The most commonly used approach is to simply include bicycle and pedestrian facilities wherever space is available or a new road is being reconstructed. As most urban roads are likely to have some short distance traffic, this may not be a bad strategic decision. However, there is no guarantee that these locations are particularly important to cyclists or pedestrians, and there is a risk that underutilized facilities will be developed, discrediting the whole idea of NMT facilities. The alternative, rational planning approach, is to prioritize the location of facilities where pedestrians and cyclists are most likely to want to go. These methods are more fully described in the upcoming GTZ Sustainable Transport Sourcebook, but also in the CROW Manual, *Sign up for the bike: Design Manual for a cycle-friendly infrastructure*, published by the Centre for Research and Contract Standardization in Civil and Traffic Engineering - The Netherlands is an industry standard. AASHTO's "Guide for the development of bicycle facilities," is another good guide. (www.aashto.org). *Productive and Livable Cities: Guidelines for Pedestrian and Bicycle Traffic in African Cities*, published by IHE Delft University, is also good and focused on African conditions.

These same texts also contain extensive information about the type of facilities that can and should be designed. The *CROW Manual* makes suggests that on facilities where traffic speeds are less than 30kph, no separation is necessary. On facilities with speeds between 30kph and 60kph it depends on the traffic flow. At 40kph, if there are more than 6000 pcu/24 hours, separate bike facilities can be justified. At over 60kph, with any significant volume of traffic, separated facilities are virtually always recommended.

If speed limits or actual operating speeds are higher than 40 kph, but the curb lane or a paved shoulder is wide enough to accommodate bicycles without any specially designated lane, a special bicycle lane is also not necessary. On such roads, more important will be the design of storm drains. They should be designed so that bicycle wheels do not fall into them. Steep open drainage ditches also present hazards for cyclists. Steep curb cuts are also more hazardous than rounded curb cuts. Cyclists are also as sensitive if not more sensitive to pot holes, cracks in the roadway, overgrown plants along the roadside, sand, gravel, and oil on the roadway, and other maintenance concerns that also affect motorists.

Sometimes the simple posting of bicycle route signs on existing streets can be important for two reasons. First, sometimes non-motorized traffic can be routed off major arterials by taking secondary and tertiary arterials. The availability of these routes, however, may not be commonly known. Coded bike routes, coupled with bike maps, can help cyclists identify more bicycle or NMV friendly routes. Secondly, it can be used to indicate that along this route traffic

signals, intersections, and roadway maintenance have been designed to prioritize bicycle and other NMV use.

Sometimes bicycles and other NMVs might be recommended to use sidewalks in specific locations, and this too can be indicated by roadway signs. Typically, this may occur on bridges or short links of high speed facilities designed with sidewalks and high speed motor vehicle traffic but no space for special NMV facilities, where NMV access is critical to avoid a serious severance problem. Otherwise, **shared bike and pedestrian facilities are generally not recommended as cyclists will tend to just move to the roadway**.

There are advantages and disadvantages of non-motorized vehicle lanes which are separated from the roadway only by a painted stripe. The main advantage of adding such a lane over having no special NMV lane are:

a.If a road is highly congested, where actual motor vehicle speeds have declined to levels below average bicycle operating speeds (roughly 12-16 kph), and if the roadway is sufficiently wide to accommodate a bicycle lane in addition to the existing motor vehicle lanes (perhaps narrowing the motor vehicle lanes will be necessary), the addition of a NMV lane will allow the NMVs to operate at higher speeds than the motor vehicles, without compromising motor vehicle speeds. This can encourage the use of non-motorized modes.

b. a bicycle lane can give cyclists a greater sense of entitlement to the road, and sends a signal to motorists that the bicycles have a clear right to be there.

c. the painted facility can lead to more orderly and predictable traffic behavior by the motorized and non-motorized modes, modestly increasing traffic capacity for the motorized modes by preventing the NMVS from occupying a full vehicle lane.

The advantages of having a non-physically separated NMV lane over a physically separated NMV lane are as follows:

a. It is cheaper
b. It is less likely to be occupied by street vendors and pedestrians
c. It is less likely to become obstructed by refuse, debris, snow, or construction materials, or wide three wheeled NMVs.
d. It is less troublesome to clean, maintain, and remove snow and debris
e. If it does become obstructed, it is easier for the cyclist to get around the obstruction.

If a non-physically separated NMV lane is selected, some determination needs to be made as to whether the main users of the facility will be standard bicycles, three wheelers, or a combination of both. This can be determined based on the data collected above. Another consideration is whether or not parking is allowed on the curb lane.

On one way streets, if the lane is not physically separated, the NMV lane should also be one way the same way. In countries where motorists drive on the right side of the road, it is

preferable to have the NMV facility on the right side of the road. Bicyclists traveling the wrong direction on a one way bike lane the wrong way are a major cause of accidents.

Ideally, parking should not be allowed to the left or right of an NMV lane, as the greatest hazard for NMVs is having a motor vehicle passenger throw open their door right in front of you. However, this is not always possible. In the US, it is considered preferable to have the parking lane next to the curb, rather than the NMV lane next to the curb, though some cities have experimented with curb-side NMV lanes. (Andrassy Ut. in Budapest, for example). Bike lanes are not encouraged where angle or perpendicular parking is allowed.

In the US, the minimum allowable width of a bicycle lane is 1. 2 meters if there is no parking adjacent to the lane. If there is parking adjacent it must be 1.5 meters or more. These measurements do not assume the use of three wheelers. If three wheelers are used, the minimum recommended NMV lane width for a one-way facility is 2 meters. This will just allow one three wheeler to pass another three wheeler which might be stopped. If NMV flows are high enough to justify wider lanes, they should be adjusted accordingly. For more detail, see the design manuals.

If the number of cyclists or cyclist equivalents (with three wheelers counting for three cyclists), rises above 150 per direction per hour, the CROW manual recommends the width of the cycle lane be increased from a minimum of 1.5 to 2.5 meters, and if volumes are over 750 per direction per hour, they recommend 3.5 meters. If mopeds or other slow moving motorcycles are allowed on the same facility, the recommend increasing the width by another half meter.

There are several advantages and disadvantages of having physically separated NMV lanes as opposed to lanes only separated by road markings.

a. They are less frequently obstructed by double parked cars or illegal use by motor vehicles and motorcycles.
b. They provided a greater sense of security to the NMV user.
c. They can allow for two-directional NMV travel even on one-way roads.
d. They ensure that NMV users will not make sudden movements into the motor-vehicle lanes or obstruct motorists.
e. They are self-enforcing.

The disadvantages include:

a. If they are too narrow, a single three wheeler can obstruct the lane
b. If the lane is obstructed, it is very inconvenient to go around the obstruction. (these two problems can be avoided by using spaced dividers as in Photo)
c. They are more prone to filling with debris, vendors, snow, etc.
d. They must be placed on the curb-side of any parking vehicles, or in the median strip.
e. They can make truck deliveries to store-fronts less convenient.
f. Facilities placed in the median strip cause special problems at intersections.

The dimensions for the facility will be roughly the same as for other bike lanes, with the exception that dimensions for two directional facilities can be suggested. The minimum width for a two-directional NMV lane with any three wheeler traffic should be 2.4 meters, with 4 meters recommended where feasible.

In developed countries, most accidents occur at intersections. In developing countries there are also a significant number of accidents between intersections, though many are caused by unauthorized crossings. There are two basic theories about how to integrate non-motorized vehicles into intersections. One is to pull them out of the intersection, and the other is to have them pulled into the intersection and clear the intersection first. The later tends to be favored by bicycle advocates.

Traffic calming is a collection of measures intended to make roadways safer for bicyclists and pedestrians without special lanes. The British publication, *Traffic Calming in Practice: An authoritative Sourcebook with 85 illustrated Case Studies* (London Publishing) is a good resource for various pedestrian improvements. The number of basic options is fairly limited. The basic principles to protect pedestrians are:

a. slow down traffic speeds through both speed restrictions and physical infrastructure changes

1. neck-downs at intersections
2. restructuring roads to meander around trees and planters and medians forcing them to go slow
3. sleeping policemen and raised zebra crossings
4. changing from smooth to rough road surfaces or using rumble strips

b. reduce the distance pedestrian needs to cross at any one time at uncontrolled intersections by expanding curbs and sidewalks and constructing traffic islands.

1. Traffic islands

There is a question about whether you can put traffic islands in the middle of a multi-lane one-way street. There are a few examples but they are rare. This is a major concern in many Indonesian cities where you have very wide one-way streets with very long distances between traffic lights or intersections.

2. Neck-downs at intersections

Most roads are wider than they need to be at intersections. Narrowing road widths at intersections not only slows turning traffic, it also reduces the distance pedestrians need to travel to cross the road.

d. send signals to drivers that they are operating on areas intended for pedestrians.

Forcing motorists to go up a bump to the level of the sidewalk, rather than forcing pedestrians and cyclists to step down a curb sends a signal to drivers they are on space designed for pedestrians. This can also be done with paint, design features, and markings.

e. physically protect pedestrian facilities from incursions by motor vehicles

Placing bollards to protect curbs at intersections prevents trucks and motorists from jumping curbs and hurting pedestrians. Bollards also are used to prevent motorists from parking across sidewalks.

f. Traffic crossing signals

In developing countries, it is quite common to have very large unsignalized intersections. These large unsignalized intersections are extremely dangerous for pedestrians and NMVs. Other traffic calming measures are more important when there is no traffic signal. Where signals do exist, not allowing right turn on red signals can help pedestrians cross safely. An increasing number of municipalities are using a phase in the traffic signal sequence only for pedestrians and cyclists to cross, allowing pedestrians and cyclists to clear the intersection before the turning motor vehicle traffic. In the Netherlands, there are entirely separate traffic signals for bicyclists, motorists, pedestrians, and trams. While this allows tram and bicycle prioritization, it is also visually very confusing to some people.

Putting in bike lanes, sidewalks, bike racks, and other infrastructure facilitating travel by non-motorized modes, if well planned and on sufficient scale, can substantially increase travel by these modes.

The success of projects aiming at improving non-motorized transport infrastructure is highly dependent on how well the facilities are planned. The argument that bike lanes do not necessarily increase bike use is selectively true. If a few bike lanes are built in a place where no one is currently cycling, and no one wants to cycle, it is unlikely to have any significant effect on ridership.

Ideally, however, from the point of view of reducing GHG emissions, new NMT facilities should be located where they are likely to generate the most *new* trips. If a city has already modeled their traffic system, the greatest potential locations for increased NMT trips are between any high origin-destination pairs for trips under 5 kilometers. Such new trips are also likely to be maximized in locations where major severance problems exist for NMT modes on a major OD pair. In Surabaya, for example, the one way street system and laws banning the use of bicycles and becaks on certain major streets and bridges made it impossible for the residents of several '*kampungs*' or lower income residential districts to reach a major popular market. Overcoming these severance problems could be very inexpensive and have a huge effect.

The other key issue is **public participation in the planning process**. If all relevant government agencies, NGOs and bike and pedestrian users groups are not involved in the planning process, the plans are likely to be designed by people who have never ridden a bicycle in their life, and are likely to ignore the real needs of the actual and potential users. If bike groups in isolation develop the plans, the bureaucracy are likely to obstruct implementation because they were not included in the planning process. Again, the GTZ sourcebook outlines recommended procedural measures for avoiding these problems.

VI.1.B. Improving NMV Technology, Affordability, and Sustainable Supply

While some obstacles to expanded or even sustained NMV use are related to traffic policy, others are specific to the NMV industry itself. The general perception that bicycles are an outmoded technology, coupled with tariff barriers, has inhibited the profitability and the level of investment into technological innovation in the sector.

Projects aimed at strengthening the human powered vehicle industry use the same basic tools that any small business development program would apply: a) technical assistance in product development, identification of sources, training in assembly and fabrication, and business skill training, and b) small scale financing. Targeting such interventions to the human powered vehicle industry has demonstrated some significant results in expanding bicycle and cycle rickshaw use.

VI.2. Successful Examples of NMT Improvements

VI.2.A. Successful and Partially Successful Examples of NMT Infrastructure Improvements

In developing countries, the most impressive recent expansion of NMT facilities has been in the city of Bogota. Bicycling had not been an important part of Bogota's mode share since at least the early 1960s, though bikes were used extensively in secondary Colombian cities. In the last three years, some 300km of new fully grade-separated bicycle lanes were constructed over a three year period under the auspices of former Mayor Enrique Penalosa. Bogota also dramatically expanded the width of sidewalks, and created a 17 km long pedestrian way, the longest in the world. As a result of this and other complimentary measures, bike use increased from 0.5% of all trips to 4% of all trips in Bogota. Elsewhere in Latin America, Curitiba and Rio de Janeiro have also both constructed many new bike lanes and bike use has increased.

In Africa, there is a somewhat successful pilot using bike lanes in Accra and Tamale, Ghana. In both cities the facilities were largely shared bicycle and pedestrian facilities. In Accra, these facilities are mainly used by pedestrians as they lack curb cuts, consistent pavement, and a contiguous network, all of which would be necessary for use by bicycle. As a result, most cyclists continue to use the roads, and cycle use remains low. In Tamale, the bike/pedestrian facilities are utilized by bikes, but they are also utilized by mopeds, while some bicycles continue to use the main road to avoid conflicts with pedestrians. South Africa is also developing some pilot bicycling facilities. There are more examples of successful pedestrian facilities and traffic calming in Africa, with Dakar, Accra, Dar Es Salaam, Johannesburg, Morogoro, and several other cities having some nice pedestrian improvements.

In Asia, many excellent bicycle lanes built in China and Vietnam in the 1960s and 1970s are being systematically removed. Bike and becak lanes were also built in several Indonesian cities, such as Surabaya, in the 1970s, and have subsequently been removed. Bangkok, Kuala

Lumpur, and Manila, by contrast, have all constructed new bicycle facilities in the 1990s. These facilities in Kuala Lumpur are shared with motorcycles.

In the developed world, all countries where bike use has been increasing significantly there has been extensive new bicycle lane construction. A study of the effects of the Delft, Holland, bicycle network constructed in the 1980s showed that trips by bicycle in the study area increased by 9%, while trips by car increased only by 5%, while in control areas bicycle use was stagnant. (Evaluation..., 1987). The construction of bike lanes in the US took off after 1990 with the passage of the Intermodal Surface Transportation Efficiency Act. German, Dutch, and Danish cities, have also built thousands of kilometers of new bike lanes. Traffic calming measures were also implemented in most developed countries after 1990.

VI.2.B. Successful Examples of NMV Improvements

There are only a handful of organizations that are working on NMV improvements. Many projects focused on NMV improvements began with a rural focus in the 1970s, and were aimed primarily at increasing farmer productivity. ITDG in England, IT Transport, and some German appropriate technology groups remain the leaders in this area. In the 1980s a large number of groups began exporting used bicycles from the US, Japan, and Europe, to Africa mainly as a charitable activity. This has led in a few countries like Ghana to the emergence of a viable second hand bicycle market. Studies indicate, however, that the vast majority of the bicycles are used in rural areas and few replace motorized trips; hence, their GHG emissions impact is marginal. Most did not lead to continuing viable commercial supply of non-motorized vehicles or a viable bicycle industry. This industry has emerged independently in many countries.

ITDP began in the 1990s to try to apply some of the lessons to these projects to urban areas. For years the Indian and Bangladeshi governments had supported projects to improve cycle rickshaw technology, but none of them led to any significant commercial adoption as they remained based at university research departments.

In 1997, ITDP began a US AID-funded Indian cycle rickshaw modernization project worked with existing cycle rickshaw manufacturers in the Agra and Delhi regions to make the vehicle more comfortable, bring down the vehicle weight, and hence to attract more passengers. Initial surveys indicated that the cycle rickshaw had not substantially changed its design since its introduction in the 1940s. Being a technology used primarily by low income people, there was little incentive for modernization and considerable risk-aversion among the business community to R & D investments.

ITDP's technical experts worked with local industry to develop a design that was more comfortable, 33% lighter weight, and carried more passengers and baggage, and cost the same to produce. This new design, thanks to extensive promotional work, has caught on commercially, and there are an estimated 8000 of these modernized cycle rickshaws on Indian roads, all being manufactured and sold with no subsidies. According to our surveys, each vehicle makes on average 9 trips per day, and their average trip length is one kilometer. While most of their passengers were taken from traditional cycle rickshaws, 11% were diverted from bus trips, 6%

from auto rickshaws, 19% from vikrams (a higher capacity auto rickshaw), and 2% from motor scooters. (Final Report to US AID, 2000) Using emission factors from Table 2 below and the Urb-Air Study from Mumbai, an estimate of 3.2 tons of CO2 emissions reductions per day is a reasonable estimate of the impact of this technological innovation. It is possible that the entire fleet will switch to the modern design over the next decade. If this happens, and if it is valid to generalize the modal shift data, 1980 tons of CO2 emissions would be reduced per day for as long as the modal shift remains. The entire project cost was only $350,000.

The project also had the advantage that the incomes of the cycle rickshaw operators were increased by from 20% to 50%, and these operators are among the lowest income people in India. This project is currently being replicated for the becak in Indonesia under the auspices of Gadjah Mada University and GTZ. (Dr. Parikesit will be at the meeting and can talk more about it.) The project is still in its initial stages.

ITDP is also trying to modernize and popularize the urban bicycle in Africa. For decades, the traditional English roadster has dominated the African bicycle industry. When first introduced, and among the very poor, these vehicles were high status items. As years passed, these bicycles became associated more and more with the rural poor. Rather than switching to modern bicycles, much of urban Africa switched instead to paratransit vehicle use. While road safety concerns were a large part of the problem, the weakness of the private bicycle industry compounded the problem. Protected by high tariff barriers, Africa's indigenous bike manufacturers never innovated, and sold high cost, low quality vehicles that quickly lost popularity. In many African countries it remains the case that tariffs on bicycles are still at 'luxury' levels while tariffs on motor vehicles are much lower. (Howe, 1993, 1995)

ITDP has been working in Africa with bike retailers, assemblers, NGOs, and the government, to popularize the use of moderately priced stylish mountain-style bicycles. By offering technical assistance and credit to small bike dealers, setting them up with bike manufacturers in China, training them in assembly, developing the specifications for new types of bicycles, and absorbing part of their risk for new product introduction, we have been able to expand the market for bicycles in urban areas.

VI.3. GEF and Other Institutional Involvement in NMT Projects

VI.3.A. Institutional Involvement in NMT Infrastructure

To date, four GEF projects have had a NMT component: Marakina, Manila, (the Philippines), Gdansk, Poland, and most recently Santiago de Chile and Lima, Peru. All of these projects have been focused on NMT infrastructure and design and promotion of NMT use.

Both pending GEF projects have had fairly consistent input and active participation by local bicycle advocacy groups; the Fireflies Brigade and BaykAction in Manila, and the Polish Ecological Club in Gdansk. The Marakina project initially intended to build bike lanes largely in places where road space was available (along a canal) rather than in locations which necessarily served the needs of the majority of cyclists (along the major roads). The plans were improved, however with the growing involvement of the NGO community, and now represent

something of a compromise between what the cycling community wanted and what the municipality was willing to consider in terms of sacrificing road space for motorists. These projects, like the fuel cell bus projects, are only now being implemented (the contract for the Marakina project was only signed this month). Both the new Lima and Santiago Projects contain bike infrastructure elements, and the evaluation of their effectiveness at diverting passenger trips away from motorized modes should provide a clearer indication of the viability of this approach.

Other development institutions have also designed and developed bicycle and pedestrian infrastructure in developing countries, though most of them are still in process. The World Bank's Sub-Saharan Africa Transport Program built some well utilized bike lanes in Tamale, Ghana, as well as traffic calming facilities in Nairobi, Dar es Salaam, Edloret, and Morogoro, using funding from the Dutch Ministry of Development Cooperation (DGIS). NMT lanes were included in several World Bank Urban Sector Loans in Indonesia, most notably in Yogyakarta. Some pedestrian safety elements were also built in the Guangzhou City Center Transport Project. The Asian Development Bank partially financed some bike lanes in Bangkok. While post-construction studies of the impact of these facilities on ridership are few, most of them were small scale pilots, did not lead to extensive replication, and hence have had minimal impact on modal split. Some of the facilities were subsequently removed by local authorities. The bike lanes built as part of the World Bank Urban Transport Project in Lima have not enjoyed impressive ridership, as they have hampered by design flaws which allowed them to be frequently obstructed by three wheelers, vendors, and refuse.

VI.3.B. GEF and other Institutional Involvement in Modernizing Non-Motorized Vehicles

Thus far, the GEF has not become involved in any projects to modernize NMV technology. While ITDG, the ILO, and UNDP have all supported appropriate transport technology projects in Africa and South Asia, they were focused primarily on rural areas, sought to reduce poverty rather than pollution, and were not well integrated with commercial activity in the sector. Most recently, new ITDP projects funded by US AID and GTZ have focused on urban areas and have sought to demonstrate GHG emission reductions.

The World Bank and CIDA (Canada) both sponsored similar projects in Bangladesh, and the Indian government has sponsored numerous other similar projects in India, but none of them ever led to successful commercialization.

The World Bank has also supported projects aimed at increasing the affordability of bicycles. The project in Lima developed a loan facility for people to buy bicycles through payroll deductions. For years the loans were undersubscribed but with on the ground promotional work the facility is now working with very low default rates. A similar pilot projects in Senegal failed when the NGO hired to run the program basically sold the bikes and absconded with the money. Efforts by ITDP to set up revolving credit facilities in India for the purchase of modern cycle rickshaws also never met with any success despite numerous attempts, and ultimately the product was sold largely through traditional financiers and fleet owners.

Projects aimed at increasing bicycle ownership are an effective way of increasing bicycle trips, and hence have the potential to reduce GHG emissions. In practice, the GHG emission

impacts are location specific. GHG impacts in rural areas are likely to be minimal. In urban areas, most of the trips are still diverted from walking trips, but as many as a quarter of the trips are diverted away from paratransit in urban Africa. Trips diverted from motorcycle, car, and taxi are negligible but this is in part because these projects have focused on low income recipients rather than upper income recipients.

VII. PROMOTION AND SOCIAL MARKETING TO ENCOURAGE MODAL SHIFT

To date, most international development institutions in the transport sector have not paid much attention to social marketing. However, some remarkable successes in shifting travel patterns, and success in other sectors make it worth a look. The new GEF projects in Santiago and Lima both contain elements to promote bicycle use, but the specific proposals remain to be worked out.

One has to start with the question as to why the bicycle industry, commuter rail, and the public transit industry is not promoting itself. To some extent they do. The main reason is they are less profitable than the automotive and oil industries, who annually spend billions of dollars on marketing. This constant barrage of advertising has a clear effect on people's behavior, and Some transit agencies are state agencies and lack experience in marketing.

VII.1. Travel Blending or Social Marketing

Several cities in Australia and Europe have developed a new technique for achieving dramatic changes in mode shares at very low costs. The technique, a form of social marketing, is known as "travel blending". The idea is to simply give people more information on their commuting options through a completely personalized process, and then facilitating changes in travel behavior. While the focus to date has been in developed countries, recent successes in Santiago de Chile indicate that it may be applicable to higher income developing economies.

The technique involves phone contact with all households in the area, identifying the proportion of respondents who would be interested in making some changes in travel behavior, and supplying them with information, e.g., public transport timetables, maps of cycling routes, information on local facilities. For a proportion of respondents there are follow-ups with household visits. In some cases the informational work is complemented by improvements suggested through the interviews, such as better access to public transport services, new bus stops, provision of new timetables, and the extension of service hours, but for the most part the technique relies upon people changing their behavior. Travel blending uses similar techniques but often also has residents complete seven-day travel diaries, which teams later analyze to devise suggestions on alternatives for the participant.

The results to date have been remarkable. In the first trial in Perth, approximately $61,500 was expended in consulting costs to conduct the surveys and information provision activities. Of the 380 households targeted, the program produced a 6% decrease in auto use immediately and an additional 1% decrease after 12 months. Public transport trips rose from 6% of all trips to 7%, cycling trips doubled from 2% to 4%. The results have held even two years

after the assistance was delivered. The technique is now being applied throughout Australia and in some cities in Europe. Similarly impressive results are being achieved at extremely low costs.

The consulting firm Steer Davies Gleave implemented a Travel Blending program in Santiago, Chile. The Santiago results suggest that Travel Blending could become part of an effective, low-cost emission reduction package for certain developing-nation cities. Steer Davies Gleave report an astonishing 17% reduction in car driver trips (as a proportion of participating and non-participating households combined), with a 23% reduction in car driver kilometers and a 17% reduction in time spent traveling.

Travel Blending techniques may be well suited to an active role by NGOs, particularly in the collection of survey data and the development and dissemination of transport alternatives. In many communities, NGOs maintain a close dialog with residents and thus would be well suited to this sort of activity.

VII.2. Car Free Days

Bogota's Car Free Days were high profile events that gave everyone in Bogota a physical picture of what the city could be like without cars. The international Car Free Days movement has caught on in Europe and many cities in the developing world, from Surabaya to Chengdu to Paris. These Car Free Days need the full support of the Municipality, and most municipalities are afraid to close the entire city during a working day. The Bogota Car Free Day was remarkable because it was the entire city during a working day. It played a key role changing public attitudes and winning support for the BRT, TDM, and NMT measures.

VII.3. High profile projects

BRT projects partially solve what is known as the 'ribbon-cutting phenomenon." Politicians love to turn up at ribbon-cutting ceremonies for the free media they create and the public perception that they are doing something. Unfortunately, this is often at the expense of more important but less high-profile activities like ongoing bus engine and road maintenance, and sidewalk paving. Like any other new and highly visible investment, a major BRT project creates its own media, but it is sufficiently inexpensive to leave plenty of funds for other critical concerns.

Meanwhile, projects helping pedestrians and cyclists have a hard time getting anyone's attention. The cycle rickshaw modernization projects solved this problem. While the newspapers are tired of reporting troubles with cycle rickshaw drivers, most find 'modern cycle rickshaws' an irresistible media story. The India cycle rickshaw modernization project was on every major television station in Delhi and Agra and in every major newspaper. The fact that the project was located in front of the Taj Mahal didn't hurt in getting international media attention. Over 10 million people were made aware of this project. This media attention not only helped educate people that human power is not inherently backward, it also helped market the new vehicles. Hiring a skilled PR firm also played a key role. Yogyakarta was selected in Indonesia for the same reason, ie. the tie in with Javanese culture and the famous nearby monuments and

palaces. This media attention alone increased the number of passengers using cycle rickshaws, as they suddenly became fashionable.

When implementing bicycle projects, like the Afribike project in South Africa, donating a large number of bicycles to important people and NGOs in high-profile media events helps win further political support, and in the case of Afribike won the commitment of Minister of Transport Omar to getting 1 million bikes on the streets over the next five years. Politicians love to show up and look like they are giving away bikes to the poor, or to protect the environment, and it costs relatively little. Meanwhile, this helps with marketing the new designs.

If a new bike lane is opened, having the mayor or other important persons on hand for the ribbon cutting ceremony will also help bring out the media, and show people that bikes and modern cycle rickshaws are *cool.*

VII. 4. Bike Races, Bike Rides, Bike Sundays, Car Free Christmas Eve, UN Events

Many bike groups raise awareness by events like 'bike to work' week, or one hundred mile bike rides linked to awareness raising events. Obviously these events are greatly facilitated if they have the support of the municipality. Many bike groups around the world raise most of their operating budget from admission price for bike rides where municipal officials agree to close down city streets to traffic for one day along the bike route. The Ride of the Fireflies in Manila was one of the more poetic, where hundreds of cyclists dressed as fireflies bicycled through downtown Manila to help people ask the question why there were no more fireflies in Manila. (ie. they've all died because of the pollution). This has become an annual event.

Organizing cyclists into riding groups also helps new riders feel more comfortable in traffic and become a social occasion. This was the idea behind popular bike to work weeks. Similarly, many more radicalized cyclists have begun 'Critical Mass' rides, a term coined by New York cyclist and pedicab owner George Bliss (I believe) based on his observation of China. These rides, when conducted in a non-antagonistic manner, can raise the profile of cycling, but if poorly organized can needlessly antagonize motorists and transit passengers.

Bike Sundays in Rio de Janeiro, Bogota, and other cities, primarily for recreational purposes, nonetheless help get people into cycling culture. Car Free Christmas Eve in Bogota has become one of the most loved social events of the holiday season.

UN events are excellent opportunities for free publicity. At the CSD #9 in New York, we convinced 9 Ministers of the Environment to ride their bikes together at the UN. The Ministers from Sweden, South Africa, Norway, France, the Czech Republic, and several other countries all rode, and in those countries the event was covered on the national prime time news. (The UN CSD 9 itself minimal coverage).

VII.5. Highly Publicized Studies

Local studies can sit on a shelf and be completely useless, or they can change the whole worldview of a city, depending on how well they are presented to the media. The most

successful media campaign based on a study was done by the Networks for Green Transport (NGT) in Korea. NGT did a study collecting all the police traffic accident data and showing that Seoul is one of the most unsafe places in the world. This study was brought to the attention of every major newspaper and television and radio station, and was used to bring about legislation which mandates that Seoul develop every five years a Pedestrian Improvement Master Plan. The chair of NGT is now a chief advisor to Prime Minister Kim. Transportation Alternatives in New York has also been extremely successful in raising pedestrian and bicycle safety issues with the media, which won state support for the successful pilot Safe Routes to Schools program.

How are the GHG emission impacts of these promotional efforts measured? Rather than trying to measure them in and of themselves, it is better to realize that these promotional efforts should form an integral part of any project work funded by the GEF, and will be critical to successful implementation. Virtually all successful promotional efforts are tied to specific projects or plans or studies, and are not 'promotional projects' per se.

VIII. CRITERIA FOR PROJECT PRIORITIZATION

No modal-shift-oriented GEF project is going to have any impact on GHG emissions if it is not implemented, or implemented badly. Good plans exist in virtually every city which, if implemented, would make a huge difference, but are sitting on shelves collecting dust. Pilot projects that were never replicated are ubiquitous. Project selection criteria should thus studiously avoid doing more studies and pilot project unless there is a clear indication that the project is likely to be implemented.

Most municipalities will not care about reducing GHG emissions but will have concerns about traffic congestion, noise, safety, and other ambient air quality issues. Fortunately, BRT, NMT, and TDM strategies are also excellent low cost strategies for reducing ambient air pollution, noise, accidents, and reducing traffic congestion. The Curitiba and Bogota experiences show that mayors who successfully address these issues are very likely to rise to national and even international prominence.

The clearest indicator of likely project success is the level of political commitment to viable solutions. A powerful and charismatic mayor like Jaime Lerner or Enrique Penalosa, or a very intelligent Director of City Planning as in the case of Quito, is the strongest indicator of the likelihood of project success. Several other measures have also been found to be critical ingredients in successful implementation. It is important that the GEF align its project selection criteria with these indicators to the greatest extent possible if GHG emission reductions are to be maximized.

VIII.1. Indicators of Local Political Will

Implementing projects that will actually shift passengers out of passenger cars require political courage as politicians are likely to be widely attacked and reviled by the press. Penalosa was nearly impeached for preventing motorists from parking on sidewalks. In Quito, Curitiba, and other cities, implementing BRT required national guard or military forces to break

up strikes by transit operators threatened with losing lucrative routes. If it were easy, all cities would be doing it.

A few probing questions to lead political officials can help determine the strength of the political conviction:

- Are you willing to take road space from private vehicles to better serve public transit, cyclists, and pedestrians?

- Are you willing to consider measures to discourage private vehicle use, such as parking controls, road pricing, and peak-hour restrictions?

- If leading stakeholder groups, such as private vehicle owners, private transit operators, and taxi providers object to the suggested measures, how will you respond?

Questions like these can provide telling evidence of likely outcomes. While there are no prescribed answers to such questions, how a political leader reacts to such questions can be quite informative in the selection process. Mayors who are unwilling to consider road pricing or other such measures should not be dropped from consideration. However, if city officials dismiss such ideas out of hand, it may not bode will for future difficult choices.

VIII.2. Institutional structures

BRT, TDM, and NMT are all projects that need to be implemented at the municipal level. By their nature, they also tend to require involvement from multiple municipal and national level agencies to be implemented. This sort of cross-agency coordination can be greatly complicated by certain administrative structures. The level of municipal government authority varies widely from city to city. In many developing countries, municipalities have limited taxation authority and limited skilled personnel, and are dependent on the national government for funds, international grants, technical support, legal approval, and policy support. Some major cities are divided into Districts, and the municipal level of government has very limited powers. In some cities, a labyrinth of bureaucracies have poorly delineated areas of responsibility, and different national and municipal agencies compete for any public spoils generated by regulatory authority. Strong opposition by an agency which finds its turf threatened can delay or kill implementation without intervention by a strong Governor or Mayor or President.

Projects supported by a strong mayor or governor with a compliant bureaucracy should be favored over projects where the coordination and agreement of a dozen District Mayors and a dozen competing bureaucracies is required for successful implementation unless these problems can be overcome by a suitably empowered task force or implementing agency.

VIII.3. Technical capacity

While the fervent support of top political officials is needed to drive the project, the skills of municipal officials and staff are crucial to the quality of the implementation. In some cities, the issue is not just the quality of the skill levels, but also the number of qualified staff. Some

city governments simply do not have the number of personnel to undertake major transport initiatives, although clever use of private sector resources can mitigate this shortcoming.

The lack of technical capacity is not necessarily a factor that should eliminate a city from consideration. In many cases, the necessary capacity can be developed as the project proceeds, and such technical assistance and capacity development is often available from national and international resources. However, the extent to which technical capacity is lacking will indicate how extensive the assistance work will need to be in order to deliver a successful project.

VIII.4. Potential for Cooperation with Related Projects by other Institutions

If the World Bank or other IFI or bi-lateral aid agency is already heavily involved in a BRT, TDM, or NMT project, or is in the midst of negotiating an as-yet ill-defined loan agreement, financing for the project can be arranged much more easily, extensive contacts can be made easily, implementation can be better monitored, public participation and accountability can be better encouraged, and a certain minimum level of institutional capacity building is likely to have already taken place.

VIII. 5. Effectiveness of Local NGOs and other Institutions

NGOs and research institutions vary widely from country to country in terms of their technical competence, political clout, capacity, and interest in transport-related issues. Having a strong local NGO or research-institution as a project partner can greatly increase the chances of project success if they are technically competent, politically savvy, respected and/or politically influential, and willing and able to work constructively with government. The lack of such institutions in China, for example, makes working there much more difficult and makes it much easier for government institutions to manipulate international agencies.

VIII.6. Competing/supporting projects, and Stage of the Planning Cycle

The entire portfolio of current municipal projects should be evaluated to determine how well BRT fits into the overall scheme. Are other projects complementary to BRT (bicycle networks, pedestrian improvements) or are they potentially competitive (light rail or metro projects) or are they counter-productive (ring roads, extensive road construction for private vehicles)? A metro project or major road project does not necessarily disqualify a city from consideration, but should be taken as an indication of the municipality's seriousness. These projects will also consume the time of scarce skilled staff, funds, and political capital.

In some cities major infrastructure projects are decided upon during a master planning process, and some municipalities are loathe to change plans that have been laboriously developed and approved. Including BRT, NMT, and TDM options at the appropriate stage in the master planning process can be critical. Similarly, political timing is critical. Most mayors and governors only have a few years to make their mark on a city, and new initiatives will have a better chance if they are developed in the early part of a politician's tenure.

VIII. 7. Demonstration value

The likelihood that the project will lead to emulation in other cities should also be considered. Curitiba's system has been highly influential in setting an example for other Brazilian cities such as Belo Horizonte, Goiania, Porto Alegre, Recife, and Sao Paulo, as well as smaller cities in Paraná State. Likewise, the Quito Trolebus played a role in catalyzing Bogota, and Bogota in turn is having a similar effect inside and outside of Colombia. Taipei and Kunming may eventually play a similar role in Asia. Likewise, a city like Cuenca, Ecuador with a population of less than 200,000 has helped set a valuable precedent for other smaller cities and is helping to prove the scalability of BRT systems. Successfully implementing BRT, TDM, or NMT projects in Southeast Asia, India, and Africa would have potentially larger regional replication effects than more projects in regions where there are already good regional models. On the other hand, this will make implementation more difficult as well.

VIII.8 Stakeholder positions

NMT, BRT, and TDM projects are likely to meet resistance from both within and outside the government. First, the opinion of the general public is of great interest. What are the current satisfaction levels with regard to the existing public transit options? How entrenched are views toward favoring two-wheel or four-wheel modes? Given the newness of the BRT concept it may be difficult to gauge potential reactions. As the process moves forward, public participation processes become a central instrument to measure public support and to utilize public inputs into the decision-making process.

Second, key stakeholder groups and their likely support will be a definitive determinant of how far political leaders can take the concept. Most notable will be the position of existing transit operators. Private sector operators may see the BRT as an opportunity or a threat, and of course, how the system is presented will influence the reaction. Likewise, other groups like automobile interest groups and taxi associations will be influential in the process. While many of these groups can be won over by showing the opportunities for win-win solutions, an existing inclination towards confrontation will undoubtedly make the job all the more difficult.

VIII.9 Financial situation

While the relatively low-cost of BRT, NMT and TDM options put them within reach of virtually all cities, there are some financial considerations that will make new projects of any kind difficult. If a city and/or country is very near its debt ceiling with international lenders, for example, may make even modest projects difficult to finance.

On the other hand, it may actually take a financial crisis to force a municipality to abandon grandiose highway plans and metro plans in favor of lower-scale, more achievable projects. BRT in Indonesia is getting a hearing today mainly because of the financial crisis. Some cities desperate for cash may be willing to impose cordon pricing. New York City, facing its worst fiscal crisis since the 1970s, for example, is considering tolls on its East River Bridges seriously for the first time in a decade.

IX. RECOMMENDATIONS FOR GEF PROGRAM ACTIVITY IN THE TRANSPORT SECTOR ENCOURAGING MORE SUSTAINABLE MODES

Deciding on an effective role for the GEF to play in helping to realize the implementation of BRT, TDM, and NMT projects that have demonstrable GHG emission reduction impacts requires careful coordination with other possible resources available. The most important activities for the GEF to support are:

i. awareness raising and overcoming political and bureaucratic obstacles to project implementation,
ii. facilitation of public participation and local capacity building during the planning process,
iii. the provision of technical support for project preparation
iv. implementation of low-cost projects

IX. 1. Awareness Raising

In some cities, particularly in Africa and Asia, municipal political officials and technical staff have simply never heard of BRT and TDM, and have never thought about NMT as a serious option. More frequently, experts have heard about such measures, but they are being pushed by French, Japanese or other bi-laterals to explore metros or light rail or big highway solutions to their congestion problems. In either case, awareness-raising with key decision makers and the public is a key element in initiating BRT, TDM, or NMT projects.

ITDP, IEA, the World Bank, GTZ, and other organizations, often working in partnership, have achieved successes through publicized workshops, conferences, press conferences, and high-level meetings between eminent BRT, NMT, and TDM leaders and experts like Enrique Penalosa and high level municipal and national officials. ITDP, working with the Foundation for the Support of Civil Liberties in Panama City, has helped authorities reconsider a French-funded badly planned LRT and give consideration to BRT. Panama City is looking for further technical support, and would like Mr. Penalosa to visit to help build political support. In Delhi, ITDP brought Mr. Penalosa and Lloyd Wright to a conference sponsored by IIT-Delhi at which the Chief Minister of Delhi green-lighted a BRT project designed several years ago but never implemented. In Jakarta, ITDP and Sustran/Pelangi sponsored BRT workshops with Mr. Penalosa which stopped a badly planned Japanese-driven MRT, and convinced the Lieutenant Governor to support a Pilot BRT instead. In Surabaya, ITDP, in cooperation with GTZ and the municipal press office, helped convince municipal officials to green-light an already designed BRT project. In Guangzhou, ITDP and the World Bank co-sponsored a presentation by Enrique Penalosa which led to the approval for the technical staff to explore BRT options. The Energy Foundation support for a Mayor's Conference in Shanghai where ITDP, WRI-Shell, and Enrique Penalosa all spoke, led to requests for technical support on BRT from Wuhan and Xiamen. SIDA from Sweden funded the technical studies for BRT in Bangalore, India. The US Ex-Im Bank has indicated willingness to support such studies in Dakar.

GEF Assistance would be most useful in the following areas:

Sponsoring Further Workshops / Technical Review Visits

Numerous cities have expressed interest in further workshops and/or technical review visits on BRT, and many of the same cities are interested in technical support on TDM and NMT measures as well. These would include those cities still in the early planning stages where political commitment is not yet assured. Involvement of NGOs, the press, and all relevant government officials in such workshops is critical to success. Many such cities have expressed strong interest in having someone like Enrique Penalosa, experts with an international perspective, and technical experts from such best practice locations as Bogota, Singapore, the Netherlands, Brisbane, Curitiba, Eugene, Honolulu, and Quito. In many cases, the participating municipalities or foreign agencies are willing to donate the time of their staff, if travel funds were available to place them for short-term advisory roles in requesting cities.

Workshops on BRT can and should be linked to workshops on NMT and potentially TDM measures as well because pedestrian and bicycle access to a BRT system is often a critical component to project success.

The following cities have expressed an interest in workshops or technical visits on BRT, TDM, and/or NMT:

Wuhan, China
Xiamen, China
Jakarta, Indonesia
Yogyjakarta, Indonesia
Dakar, Senegal
Port Harcourt, Nigeria
Accra, Ghana
Delhi, India
Shenyang, China
Rio de Janeiro, Brazil
Panama City, Panama
Cartagena, Colombia
Guatemala City, Guatemala
Guayaquil, Ecuador
Cape Town, South Africa

Further Development of Outreach Tools

ITDP, W. Alton Jones, US FTA, GTZ and other development agencies have already developed or are developing many useful outreach tools for presentation and dissemination at these workshops. However, the following additional materials would be extremely helpful and could be made available on web-sites:

- Further documentation from existing projects – While ITDP has good visual materials with extensive factual data and promotional concepts on BRT, this information is not at a high level of technical detail. Documentation of successful NMT and TDM projects is much less well developed. A compendium of planning documents, tendering agreements, and sample contracts from existing projects would be invaluable to new efforts.

- Technical guidance documents – As a relatively new field, the documentation of technical details from BRT has not kept pace with the actual practice. Some topics, such as new customer service techniques, are devoid of up-to-date documentation. In other cases, existing materials merely need to be translated into local languages, particularly French, Chinese, and Indonesian. A fair amount of planning materials exist on NMT facilities planning, but they are virtually all focused on developed countries, and require significant modification for developing country contexts, with a different vehicle mix, a much more pronounced issue of street vendors, a very different road grid, and other differences. Extensive further work is needed in this area. There is also only patchy documentation of TDM measures.

- Directory of transit consultants – As the technical nature of the project deepens, the inputs of NGOs and international organisations should give way to professional consultants with specific skill areas. While it is important to maintain objectivity and not recommend a specific consultant, municipalities often have no idea where to turn for detailed assistance. A directory listing consulting options and specialties would prove useful for BRT, TDM, and NMT.

- Directory of finance organisations – As noted, finance has not proven to be a substantial barrier for any of these low cost interventions. However, it would be useful to provide a document outlining the options.

- Directory of equipment suppliers – Again, in order to maintain an objective and neutral role, we would not want to recommend any particular technology or private firm. Nevertheless, it would be extremely helpful for developing-nation officials to have a full view of the options through directories listing all suppliers of buses, fare collection equipment, bus propulsion technology, station modules, electronic road pricing, bicycle technologies, bicycle parking technologies, other commercially available human powered vehicle technologies, traffic signalization for non-motorized modes, and a host of other facilities to ease and make more objective the procurement process.

Study tours

W. Alton Jones achieved incredible success with its Curitiba study tour programme. After a visit by Mayor Riordan to Curitiba, Los Angeles went on to develop its impressive BRT system. And after US Federal officials visited, they launched their 17-city national BRT programme. The Zurich-Kunming Sister City project brought all the relevant senior officials in Kunming to Zurich, which secured their support for the BRT project there. Such tours are often as important for building relationships and trust, and as a mechanism for gaining the cooperation of public officials who cannot for legal reasons be contracted to work on projects by foreign agencies. Similar study tours could be used to popularise NMT improvements to the Netherlands, and for TDM measures to Singapore and potentially London, could be similarly effective.

IX. 2. Facilitating public participation and local capacity building during in the planning process

The chances of BRT, NMT, or TDM projects being successful are greatly increased if the planning process is done in a way that involves relevant stakeholders, implementing agencies, potential suppliers, and funding agencies from the inception. Because of the numerous vested interests involved, having an outside institution facilitate a broader planning process is often necessary. One government agency may not want to talk to another one, NGOs and community groups may be completely excluded from the process, facilities might be designed with no attention to how people are expected to get to and from the stations, etc. In any project of this kind, NGOs are critical watchdog institutions to ensure that technical details are decided based on technical or social concerns rather than the political influence of the supplier.

Without dedicated in-country facilitators and experts, pushing projects forward and helping to overcome obstacles, sustainable transport initiatives can needlessly languish against other distractions. Often, when political leadership and key government personnel change, projects die or are extensively delayed. Having full time advocates and experts based at research institutions and NGOs, whether indigenous or local branches of international institutions, can ensure project continuity, build indigenous independent local capacity, and can often play a key role in overcoming bureaucratic or political obstacles.

IX. 3. Technical Support for Project Preparation

Funding from the PDF B mechanism could help deliver full BRT, NMT, and TDM plans and could be a contributing resource for the implementation of initial pilot projects if insufficient other resources are available. While in developed countries, simply the design work for a major bus terminal or roadway intersection can run into the millions of dollars. However, in developing countries, where extensive local hiring is possible, BRT plans can be developed for anywhere between $100,000 to $800,000. NMT plans for small pilot projects can be done for less than $100,000. The cost of TDM plans will vary widely depending on what is involved.

While the development banks, some bi-lateral aid agencies, and export-credit agencies are already involved in transport sector project preparation, they rarely spend sufficient funds or attention to BRT, TDM, or NMT facility planning and design, but add these elements as an afterthought, or for window-dressing to secure Board approval for otherwise dubious projects. GEF support for these specific measures with demonstrated GHG emission reduction benefits could help to leverage World Bank and other IFI project development funds to these uses. Municipalities and/or national government should also be required to pay or borrow for a significant share of the cost as a demonstration of their political commitment to the project. Government agencies in many countries have stacks and stacks of planning documents for different projects funded by international development agencies that they have no intention of implementing.

Technical expertise for the plans may also be donated by bi-lateral aid agencies or paid for by export credit agencies. While these sources of money are often indirectly tied to a

specific bus or other technology supplier, the GEF could help to leverage these funds while ensuring that the municipality has sufficient support to make a rational choice of technology based on the merits. One advantage of World Bank/UNDP/GEF support for the technical studies would be that it could in theory be more objective, subject to competitive bidding, and hence less tied to encouraging the sale of a particular bus technology.

GEF participation might also help ensure that project development is done in such a way that it develops local capacity to design similar projects without the need of foreign consultants. NMT, TDM, and BRT projects are fairly simple to plan and design once the techniques are learned by local planners. Conversely, if foreign experts are necessary each time a new bike lane is built, the consulting costs alone may make even the simplest of measures prohibitive.

IX. 4. Matching Funds for Low-Cost Project Implementation

BRT, TDM, and NMT measures are all extremely low-cost and cost effective: so low cost that the GEF could decide to fund the entire implementation for a few pilot cities and still be within its budget. However, as the primary obstacle is generally lack of political will as much as lack of funding, full GEF funding for such projects may not be the best way to ensure implementation. Many municipalities and national governments should also be able to fund all or part of the actual implementation costs. Many of these governments are already spending millions if not billions of dollars in public funds for auto-oriented new highways and fly-overs, or glitzy new metro systems. If the municipality is unable to find its own resources to support the actual construction cost or at least be willing to borrow the funds, but does have funds for other major infrastructure efforts, this is a strong indication of the lack of sufficient political commitment. Very poor countries may lack the implementation funds, and could be considered if a track record of clean governance and solid implementation is indicated.

The entire Kunming BRT system was built for around $8 million, though most BRT measures have more elegant features and are considerably more expensive, costing up to $5 million a kilometer. NMT facilities can also vary widely in price, depending on the type of facility. Typically, several hundred thousand dollars is spent on a pedestrian overpass that is not even used, while the several thousand dollars needed to repaint zebra crossings is neglected. Sometimes a multi-million dollar bike lane may be less important than removing bans on bicycles on one or two key arterials, and the replacement or covering of dangerous storm drains. Sometimes bike promotion efforts may be more effective than infrastructure.

As TDM measures such as congestion pricing and parking charges generate revenue streams with economic rates of return in the 100% to 1000% range, there is no reason that the parking meters or electronic road pricing technology necessary could not be covered by loan funds, though support for public awareness and technical assistance may be critical. Location-efficient mortgage pilot programs, and location-efficient low income housing pilot programs might be interesting pilot GEF projects **f** there was a reasonable chance of a demonstration effect and synergy with other low income housing efforts. UNCHS would be a good implementing agency for this sort of pilot given their expertise in housing.

X. CONCLUSION

Reducing GHG emissions in the ground transport sector is difficult, but not impossible. The difficulty is one reason why GHG emissions in the sector are growing faster than in any other sector. While the problems of ordinary emissions such as NOx, CO, VOCs, ground level ozone and particulates can be significantly addressed by emission standards, inspection and maintenance measures, and vehicle fleet modernization, and GHG emissions per vehicle can be reduced by more efficient engines, none of these measures do much to slow, let alone reverse, the growth of total GHG emissions in the transport sector.

GHG emissions reductions from hydrogen fuel cell vehicle demonstration projects in developing countries offer some long term hope, but offer little in the short and medium term. Projects and approaches that have focused on inducing a shift in passenger trips towards more energy efficient and non-polluting modes have a mixed track record. They only work when a high level of political commitment is found or generated, when the plans are done well, and when municipal or national authorities are capable and willing to implement the plans. However, there are a growing number of institutional actors with successful experience in the sector, growing public awareness of the problems, and more and more successful project experiences to draw upon. This project experience should provide extensive guidance to GEF transport sector program activity.

PARTIAL LIST OF SOURCES

www.aashto.org (to order **"*guide to the development of bicycle facilities*")**
www.crow.nl **("publications" "records" to order *Sign Up for the Bike)***
http://www.nottingham.ac.uk/sbe/planbiblios/bibs/sustrav/refs/ST05.html
Numerous British traffic calming references.
www.saferoutestoschool.org (to learn about the New York City Safe Routes to Schools Program)
www.transalt.org (a good web-site of New York City bike-related information, including links to bike regulations in the US)
www.itdp.org (numerous resources on NMT-related issues)
www.transact.org (Lots of advocacy resources for NMT focused on the US)
www.worldbank.org (To order World Bank publications listed below)
www.adb.org (to order "Vulnerable Road Users in the Asia and Pacific Region," Stock No. 010499)

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