RESEARCH, INDUSTRY & STAKEHOLDERS' DAY

Wednesday 28th May 2008

Workshops:
Conclusions and Key Findings

Conclusions and Key Findings

Wednesday 28th May 2008

Workshop 1
Advances in energy-efficient transport technologies

Chair: Julia KING
Aston University

Workshop 1 Advances in energy-efficient transport technologies

MAIN FINDINGS

Potential and timescales for technology-based fuel economy improvement

- 30% fuel economy improvement is obtainable through advances in conventional or mainstream automotive technologies. Improvements of 50% and above over are likely to require hybridization. Longer term, going beyond 50% is a real possibility through electric vehicles and/or fuel cells.
- Critically, if we are to deliver significant reductions in CO_2 emissions we need to ensure all of the technological potential is used to improve fuel economy, not to increase performance. In this situation, achieving 30% improvement in new cars within a decade is realistic.
- Although policy should be designed to support the development of technology for the long term without picking winners, there is a fairly widespread view that electric vehicles will outperform fuel cell technology in terms of reduced cost/complexity and total CO_2 emissions because of the additional losses incurred by using H_2 as an energy vector.
- The development of high power density, sustainable battery technologies is a key research priority and requires funding not only by industry but also by government.
- Driving behaviour has a significant effect on fuel consumption. Introducing technology to run cars in standard 'eco driving' settings could have considerable payoffs. The technology should be implemented in such a way that drivers are "locked into" the most efficient driving mode, and moving out of it requires action.

Technology costs

- The costs of introducing mainstream technology, to improve fuel economy by some 30%, range from zero to small in the sense that any increase in the purchase price is compensated by savings on fuel within two to three years. One example quoted was a seven speed double clutch transmission which improved fuel economy by about 7% compared to a standard manual box, at no additional cost.
- Since history shows that such 'no-regret' options are not necessarily taken up by consumers – indeed that consumers typically apply 'implicit discount rates' of 40 -60% to future savings – there is a justification for policy intervention to deliver significant CO_2 savings in a short timescale.
- The current costs of improving fuel economy by 50% are higher. An example quoted was a lithium-ion battery powered electric car with a

driving range of around 100 km, estimated to cost about $5000 more than an equivalent conventional vehicle. Including costs for more complex hybrid propulsion systems could inflate the additional cost to some $7000, or roughly 20% to 30% more than a conventional car. Historical data suggest that motor industry cost reduction, post regulation and with a mass market, is typically in excess of 50%.

- While there is no single vision of what future automotive technology will look like, it was felt that low carbon alternatives are not excessively costly, on condition that electricity or hydrogen can be produced with low CO2-emissions.
- The introduction of vehicles that are significantly more expensive to buy but cheaper to use could be accelerated through new business models. For example, spreading the cost of batteries over the lifetime of the vehicle through leasing arrangements could speed up market penetration of hybrid and electric vehicles.

Test cycles better calibrated to real world driving

- The differences between standard test cycles used to rank vehicles and real on-road driving performance, especially in congested conditions, need to be minimized. 'Design-to-the-test' will occur, potentially inhibiting the introduction of some beneficial technologies and jeopardizing the effectiveness of fuel-economy standards. Ongoing work in this area, e.g. by UNECE, should be supported, and widely discussed to ensure that optimum standards are developed and accepted internationally.

The Fuel Economy Standard is a key policy instrument

- Whether all technological potential will be used to improve fuel economy is dependent on policy, because in an unregulated market at least part of the potential is likely to be used to enhance performance, as has happened historically. A fuel economy standard is a key component of a policy package that stimulates the use of technology to improve fuel economy.
- The car industry generally welcomes a fuel economy standard approach as it reduces uncertainty, and many companies believe it produces a level playing field.
- In the interest of driving further technological development in a rational way across all fuel types, the standard should be expressed in units of kWh/km, not just litres/km, as the latter only applies to liquid fuels. The difficulty here, however, is that the carbon-intensity of electricity production differs markedly among countries. For example, in Sweden using a particular electric vehicle would result in emissions of 6g/km, 12g/km in France, 72g/km in Germany, whereas for Greece it would be 120g/km (Oliva, 2008).

The pressing need for 'clean and green' electricity

- Going beyond 50% fuel economy improvement, the benefits of new automotive technology are strongly dependent on the emissions levels associated with the electricity supply. Since the costs and timescales for new technologies and power generation plants are many times those in the automotive industry, this must be a priority for governments.

Preventing an increasingly carbon-intensive energy supply

- In contrast to the vision of 'clean and green', there are concerns that transport fuels are being produced in a more carbon-intensive way as oil prices rise (e.g. using non-conventional sources of oil, such as oil sands, to supply 10% of the market increases CO_2 emissions by 1.2%; Heywood, 2008). Avoiding this evolution requires policies covering all fuel types – not just biofuels - which are based on the carbon content of the fuel.

Taxation

- As the UK experience with the company car tax shows, differentiation of tax breaks according to CO2 emissions can strongly affect company car choices, an important market segment in many countries. Differentiation of annual 'circulation' taxes is effective in modifying the choice of vehicle type as well. These are useful policy instruments, which can deliver quick results in a sector where carbon taxes are unlikely to be implemented fast.
- Clear policy targets for deep emission reductions would justify a high carbon price. This might mean that prevailing excise duties on auto-fuels in Europe (200 – 300€ per ton of CO2) should apply as a carbon tax to all fuels. Such a radical change would pose a tough political challenge.

Developing economies

- The debate very much focussed on OECD countries, but it was pointed out that managing emissions in the fast growing, emerging economies is of critical importance with their low but rapidly growing levels of car ownership – less than 1 vehicle per 100 people in India and China today, compared to levels around 50 per 100 in the US and Europe. While OECD countries may take the lead, technology collaboration with emerging economies is highly desirable. There is a role for public funding to support such collaborative efforts.

Conclusions and Key Findings

Wednesday 28th May 2008

Workshop 2
Changing Behaviour in Passenger Transport

Gerd-Axel AHRENS
Dresden University

Workshop 2. Changing Behaviour in Passenger Transport

Policy levers

Governments have several levers to help guide travel decision-making in a way that produces the largest benefits, including mitigation of greenhouse gas emissions, at the lowest possible costs. Salon and Sperling (2008) propose developing the appraisal and planning process to provide an integrated climate policy instrument for local governments in the form of city carbon budgets. This would mean integrating climate change policy with transport policy, using instruments that involve influencing the pattern of land use development, the intensity of car use and the efficiency of public transport systems. This approach combines an enforceable cap with the full freedom and flexibility to select locally appropriate measures.

The full range of levers include:

- Investment choice and financing for road and public transport networks;
- Pricing of parking, road use and public transport;
- Vehicle and fuel taxation;
- Rules regarding traffic, parking, access and use of the network;
- Transport infrastructure planning and its coordination with relevant land-use planning systems;
- Policy appraisal processes and methodologies, which have a real impact on transport decision-making.

Transport authorities have in the past largely treated travel demand as an exogenous factor that simply must be catered for, resulting in a series of “predict and provide” infrastructure development projects. A growing realisation that such policies not only meet demand, but spur it as well, and that catering to demand when prices are below social costs eventually is ineffective, has led many authorities to re-assess their approach. The construction of new roads or the freeing-up of existing capacity leads to a decrease in travel times and thus to a decrease in the generalised cost of travel. Consumers respond to this by adapting their trip-making frequency, patterns and mode choice. The “induced” impact of new capacity is not bad in itself as it can reflect suppressed demand but it can erode the expected benefits of road construction or widening schemes. The induced travel effect can also come into play as a result of any successful policy to draw cars off the road which, without flanking measures, increases available road capacity. Conversely, reductions in available road capacity have been found to have lasting impacts in reducing traffic demand. As in other sectors (electricity, water) there is a growing focus on managing demand for transport infrastructure to contain the negative consequences of unmanageable traffic growth.

The potential to change passenger behaviour

Goodwin (2008) notes that although travel behaviour is sometimes described as ”too difficult to change” there are very many kinds of behavioural choice. These are in constant flux and subject to a wide range of incentives. A key point often overlooked by policy is that net trends in transport demand often hide significant changes in specific household behaviour. A net increase in passenger kilometres of 2% might hide the “churn” resulting from an important number of households decreasing their travel (-20%) as compared with those increasing their travel (+22%). Goodwin cites evidence to suggest overall reductions in car use of up to 20-30% are possible. Tony May (May, 2008) also points to a potential of -20% car travel in European urban areas from the deployment of a comprehensive and self-financing package of measures.

There are many more travel choices over and above choosing between cars and public transport, including the volume and location of travel, using other modes notably walking and cycling, driving style, car ownership, and where to live and work and shop. In general responses are often rather small in the short run, but build up to very much more flexible life-style choices in the longer run, in which habits are eroded and new ones form. There is a large volume of empirical and case study evidence about the effect on travel behaviour of changes in price, speed of travel, quality of travel, information availability and other factors which can be influenced by public or private interventions. A common characteristic is that these interventions have mostly been chosen for objectives other than carbon reduction, including congestion reduction and quality of life improvements. Where such interventions produce net benefits there are carbon benefits for zero real resource cost.

Available studies on fuel price elasticities over the short- and long-run[1] show clear and emerging regional differences, but there are two principal findings that are both robust and important:

- The main response to increasing fuel prices is to decrease fuel consumption (via vehicle choice, vehicle size choice, changes in driving styles) rather than decreased car travel. The elasticity of fuel consumption is at least twice as high as the elasticity of travel volume.
- Long-term elasticities are at least twice as long as short-term elasticities which indicates that many behavioural responses (vehicle

[1] 5 to 10 years.

purchases, housing and job decisions, etc…) take time to have an impact. This holds true for both the elasticity of fuel consumption and of travel volume.

Goodwin's summary of elasticity values (Table 1) differs from those found from a recent comprehensive study of responses to fuel price changes in the United States (Small and VanDender, 2007). Lee (2008) also finds lower short-run traffic volume elasticities with respect to fuel price than the Goodwin review, ranging from -0.078 to -0.171 for the greater metropolitan Seoul area depending on the alternative modes to the car likely to be chosen – bus, subway or a combination of the two. While there is no clear explanation for the difference in estimated elasticities, there are several plausible factors that likely play a role. The principal factor is the income effect – the United States has higher per-capita income than many of the countries whose elasticity values are referenced by Goodwin et al. Per capita incomes have risen in the United States as fuel price elasticities have fallen, as can be seen from the Small and Van Dender's estimates for 2000-2004. Higher incomes cause the share of fuel expenditures in total expenditures to decline, which may lead to lower elasticities. Higher incomes also lead to higher values of time, so that time costs of travel become relatively more important than fuel costs. Higher fuel costs then translate into proportionally smaller increases in the generalized price of travel (which is the sum of time and money costs), and assuming that drivers respond mainly to this generalized price, this reduces the elasticity with respect to the money costs. Note, however, that by the same logic higher fuel prices will lead to more elastic responses, which is consistent with the large effect that current fuel prices are having on the sales of relatively fuel-intensive light trucks in the USA.

Small and Van Dender's results suggest that fuel consumption by passenger vehicles has become more price-inelastic over time, and that it is increasingly dominated by changes in fuel efficiency rather than in amount of driving. Their results identify two main reasons for this: rising incomes and falling real fuel prices. One of these – rising incomes – can be presumed to characterize the future as well, even if falling real fuel prices probably cannot.

Lee finds that the cross-elasticity of public transport fare prices to car travel is insignificant whereas car users' responsiveness to changes in parking prices measured in terms of car travel volume is greater than their responsiveness to fuel prices, highlighting the importance of parking policy over public transport fare policies in seeking to change overall volume of car travel.

Table 1. **Review of Recent Fuel Price Elasticities**

		Short-term	Long-term
Goodwin, Dargay and Hanly (2004)			
Summary of 69 Studies undertaken from 1992-2004	Fuel Consumption	-0.25	-0.60
	Traffic Volume	-0.10	-0.30
Small and Van Dender (2007)			
US 39-year cross-sectional time series of data at the State level (1966-2004)			
1966-2004	Fuel Consumption	-0.074	-0.363
	Fuel Intensity	-0.035	-0.193
	Traffic Volume	-0.041	-0.210
2000-2004	Fuel Consumption	-0.041	-0.237
	Fuel Intensity	-0.031	-0.191
	Traffic Volume	-0.011	-0.057

Effects of "Soft" Influences on Travel Choice

Recent research has examined measures that change behaviour without changing the speed or cost of travel but instead seek to provide better and more targeted information to travellers on travel options. Cairns (2004) in a review of the literature found that such measures coupled with new opportunities to change behaviour arising from teleworking, car pooling, school travel plans etc., could result in a reduction of urban peak-hour road traffic of as much as 21% in the UK (11% nationwide) given sufficient support. However, these studies often target small groups of travellers and it is unclear whether these results can be scaled up to the population at large.

One clear finding on the psychological determinants of travel behaviour is the importance of habit in travel decision-making. Goodwin (2008) notes that people rarely base their daily travel habits on reasoned best-interest after weighing all the travel options available to them, even when they have all the necessary information on travel costs and options. Travellers are more likely to make decisions by force of habit. Thus interventions seeking to change travel behaviour should focus on providing information at those times when travellers are developing new heuristic rules or travel habits (e.g. when moving into a new area, when acquiring a driving licence, when changing jobs, etc). This finding may be of particular interest for policies seeking to develop public transport use. Information campaigns in the context of mobility management initiatives in the workplace have proven to be particularly effective in this context.

Ecodriving

Ecodriving has become a key element of national strategies to reduce CO2 emissions in a number of countries. Ecodriving has significant potential to deliver CO2 reductions quickly and cost-effectively; there appears to be a savings potential of 10 percent of surface transport sector emissions. Critics of ecodriving state that it is difficult to keep the habit once the training is over, especially in case of private drivers where economic incentives are not as obvious as in case of commercial operations. However, in-car equipment such as gear shift indicators, cruise controls and on-board computers giving feedback on fuel consumption help improve fuel economy. Instrumentation alone can deliver around five percent savings and provide and incentive to maintain and even improve driver performance after training. Cars are increasingly equipped with on-board computers that have an instantaneous fuel consumption readout function. Making this the default display would be a cheap and effective way to promote fuel-efficient driving. Introducing more advanced technology to run cars in an ecodriving mode as standard could achieve significant fuel savings. Ecodriving is already required to be taught to novice drivers under EU regulations. Testing ecodriving skills as a part of the driver licensing examination might result in significant CO2 emissions savings (ITF 2007).

Avoiding Oversimplifications

Travel behaviour is embedded in a web of other behaviours and decisions (Bonnafous 2008). It cannot be dissociated from work, housing, household, leisure and other social and economic systems that have an impact on the number and nature of trips taken. Isolated measures that seek address only one component of travel decision-making may have unintended consequences due to the complex interactions involved – e.g. measures to reduce work-related trips can lead to an increase in leisure-related trips. Another example of counter-intuitive policy outcomes are parking restriction measures to reduce the number of car-trips lead to an increase in increase in congestion due to "cruising" for rare parking spaces. Some basic and transparent accounting for the complexity of trip-making decisions must be integrated into transport and land-use policies to avoid the most extreme unforeseen consequences.

Policies seeking to influence travel behaviour – especially fiscal and pricing policies – have a real impact on the distribution of costs and benefits. Policies that might bring about the greatest change in behaviour and those that are most efficient from an economic perspective may not be the most fair from a social perspective. This finding cannot be ignored since the acceptability and the durability of pricing and fiscal policies often hinges on it. Impacts on lower-income households that are "captive" automobile users are particularly sensitive. Flanking measures that address the redistributive impacts of pricing and fiscal policies are important. At the same time, one may question whether distributional objectives should be pursued through transport policies and whether efficiency improvements in transport should be given up because of distributional issues. Other policy instruments, targeting income distribution, appear more suited to attaining equity targets.

Conclusions and Key Findings

Wednesday 28th May 2008

Workshop 3
Reducing CO_2 Emissions in Goods Transport

Werner ROTHENGATTER
Karlsruhe University

Messages of Workshop 3 (Freight and Logistics)

I Situation and trends

- **Status quo observation**

Freight transport and logistics are responsible for about one third of the carbon footprint of transport with a strong tendency to grow further. As freight transport is related to trade and global exchange the „natural" growth rate exceeds that of GDP such that a decoupling from GDP is difficult although not impossible.

- **CO_2 implicitly included in company planning**

Firms try to plan their logistics efficiently, considering the rising costs of fuel. There is eventually a correlation between a firm's aim to reduce costs and the social goal to reduce CO_2. Nevertheless a substantial potential can be identified to increase carbon efficiency at the individual firm level as well as through cooperation between logistic players.

II Potential actions of logistic players

Firms can reduce CO_2 emissions through using better technology, improving logistic concepts and operations or employing alternative modes of transport. Technological innovations include more fuel efficient engines, aerodynamics, weight and tyres. In the short run the contributions may be modest, while in the longer run stronger innovations can be expected if oil prices increase and the R&D activities of truck manufacturers intensify. A major technological leapfrog through hybrid technology or hydrogen based propulsion can only expected in the long run.

Education of drivers (eco-driving) can contribute to fuel savings. Optimisation of tour planning, increase of loading factors and better consolidation of consignments will lead to less vehicle kilometers and associated fuel consumption. Modal shift to railways, IWW and coastal shipping presupposes an adequate logistic quality of alternative modes, which in general is only possible on long distances and for high transport volumes. Commercially oriented railway companies might be able to develop and become predominant players on European corridors, in particular for seaport-hinterland transport.

Companies prefer to plan their logistic concepts and operations independently because they regard logistics as a part of their market strategy. The increase of transport and logistic costs might give rise to a change of such stand-alone strategies. A further consolidation of supply chains can be achieved through new alliances between forwarders, haulage companies and the shipping industry. This can result in a substantial reduction of vehicle kms compared with a stand-alone optimisation of company logistics. It can reduce the volume of direct delivery activity and just-in-time service as well lower inventory holding.

III Political Instruments and Voluntary Agreements

- **First-best instrument for CO_2 reduction**

A global CO_2 emission trading system is a first-best solution from the economic point of view. In such a world-wide regime, which would include all economic sectors, the market would decide on least cost strategies. The contribution of the freight transport sector to CO_2 savings would result from market processes. Most probably the costs of mitigation of CO2 emissions in the transport sector come out higher compared with other sectors like energy supply, manufacturing or households such that a lower contribution would be required from freight transport. In some studies a reduction of 10% in the transport sector until the year 2020, compared with 1990, is regarded as a big achievement. As all sectors would be included in a trading scheme, aviation, maritime and inland waterway transport would also have to contribute. These are presently free of carbon-related taxes because of international agreements.

There are a number of institutional problems arising from such a scheme, because the critical points for its effectiveness are the fixing of periodical caps and the allocation of allowances. Although it is possible that the system is discussed and developed further in the course of developing a post-Kyoto agreement it seems improbable that it can be workable in the medium term.

- **Second best strategies**

Second-best strategies include all kinds of partial policies to tackle the climate goal (taxes, charges, regulations, standards, investment in alternative modes). A first example is partial emissions trading schemes, for instance including aviation and eventually maritime or inland waterway transport into the Emission Trading Scheme (ETS) of the EU. Another type of partial policy is the setting of obligatory standards for the CO_2 emissions of the truck fleet, comparable to the 120 g/km policy for cars of the European Commission. This policy towards cars faces a number of problems including agreeing a penalty scheme. In the case of trucks the complexity will be higher.

In Japan the „Top Runner Concept“ has proven a successful strategy to stimulate firms to apply environmentally best technology. The best vehicle in class pays the lowest tax today and moves to a medium tax class in the future. In Europe a similar effect could be achieved if CO_2 emissions could be introduced in the forthcoming Euro 6 standard for vehicle emissions. In this case CO_2 emissions could be used for differentiating charges according to Directive 2006/38 for charging heavy goods vehicle on motorways. It has been observed in Germany and Switzerland that the differentiation of charges on the base of Euro categories has a substantial influence on the purchase of new vehicles. Haulage companies have jumped from Euro 3 to Euro 5, while Euro 4 is not preferred because the vehicles are charged a higher rate than Euro 5.

Pure and rigid regulation policies have to be regarded with care. In many cases such policies, which may for instance include sector specific transport bans or obligatory use of environmentally friendly modes, induce undesired side effects.

The state can also intervene through appropriate investments. Provision of ITS infrastructure for example contributes to a better management of bottlenecks in road infrastructure and improves the reliability of transport services.

Second-best policies face two problems: (1) It is necessary to define a reduction target for the freight transport sector or to quantify its external costs reliably. (2) International harmonisation is necessary to avoid differences of environmental treatment that could lead to counterproductive arbitrage practices (e.g. outsourcing or outflagging).

Companies are increasingly interested in demonstrating their CO_2 performance to customers, NGOs and the State, such that voluntary actions will become a most important element of climate policy. They can contribute to reduce the intensity of measures like taxes, charges or regulations. Possible platforms are ISO 14064 and NTM. Carbon auditing and benchmarking are further measures to improve the company’s environmental image.

DHL gives a best practice example for voluntary action of the industry by setting a CO_2 reduction target for the company (including the suppliers involved) of 30% to 2020, based on 2007 emissions. Other companies have started with similar entrepreneurial strategies, making carbon reduction a management goal and thus creating management incentives for small savings that result in substantial achievements overall.

IV Cost Effectiveness

- **Data availability and measurement problems**

A common and high standard data base as well as widely accepted measurement methods are important to set reliable benchmarks for controlling emissions and to make yardstick competition of companies possible. Until now these preconditions are not met, and estimations of CO_2 emissions of freight transport activities are unreliable. This makes it most difficult to compare the results of best practice reports and to develop a ranking list of measures according to cost effectiveness.

- **Short, mid and long-term measures**

Short-term measures include voluntary agreements, ecodriving, and reinforcing existing business strategies to save energy. Transfering best practices like the Japanese Top Runner Programme can also be implemented within a few years. Other examples are changes of vehicle taxation to include carbon emissions in the scheme, for example in the forthcoming definition of EURO 6 truck emissions standards in the EU, and differentiation of infrastructure charges based on Euro class.

Mid-term measures could include modest technological changes, city road pricing, extension and completion of interurban road pricinig concepts (incomplete road pricing systems, including only motorways or heavy goods vehicles have little impact on bottlenecks) or the integration of railways into supply chains. New cooperation concepts, as in the case of logistic alliances, need several years to be developed and implemented. Such changes presuppose a very careful rethinking of present strategies.

Long-term measures include technological innovations (hybrid technology, hydrogen-based propulsion systems), change of logistic networks (warehouses, inventories, supply chains) and basic changes of the spatial production patterns. The state can foster such developments by supporting R&D and pilot projects.

Conclusions and Key Findings

Wednesday 28th May 2008

Workshop 4
Transport CO_2 Emissions in Emerging Economies

Marc JUHEL
World Bank

Workshop 4. Transport CO_2 Emissions in Emerging Economies

Development imperative

Adequate transport infrastructure and services are essential for economic development and improving welfare. As developing countries grow, transport activity will also grow. This growth should be welcomed but steered to take a more sustainable path than would be the case without intervention from government to provide a planning, regulatory and pricing environment that promotes welfare for all citizens. This includes improving air quality and road safety, and managing congestion. These local problems likely will, and probably should dominate the agenda of governments in emerging economies but policies to address them also provide opportunities to mitigate CO2 emissions.

Private Motorised Transport Fleet Growth

Car ownership has entered a phase of exponential growth in the largest emerging economies. Regulating for cleaner fuels and for all new cars to be equipped with catalytic converters will be essential to improving air quality. Regulating fuel efficiency will be essential to containing growth in CO2 emissions and fuel consumption, with the balance of payments implications that has for most emerging economies. Auto fuel is untaxed and indeed subsidised in many middle and low income countries. This kind of support to business and to low income families is financially unsustainable, as recent oil price increase have demonstrated, and inflates fuel consumption and CO2 emissions.

The fuel economy of new cars sold in emerging economies is relatively high. In India and China the average performance of new cars already matches or exceeds the US targets for 2020. This is mainly because of the small size and low power of the cars in developing countries. In turn this reflects fuel pump prices that are higher relative to incomes than in OECD countries (despite fuel subsidies).

Fuel economy is clearly important to consumers and they can be assisted in making the best choice of car by vehicle testing and labeling schemes. Brazilian car manufacturers have recently entered into a voluntary agreement with the government to begin testing popular ranges of vehicles for fuel economy and provide information to consumers at sales outlets. Testing facilities exist in other emerging economies but have not been used as yet to measure fuel efficiency, concentrating on exhaust emissions. There is scope for governments and independent associations, such as automobile clubs, to develop testing and labeling schemes to “mobilise the demand side potential”. Driving in heavily congested traffic and on poor roads, characteristic of many developing countries, increases fuel consumption greatly and therefore specific tests for fuel economy that reflect these conditions may be required to ensure the information provided is reliable.

Ownership of auto manufacturing is increasingly global but markets differ widely. The technologies currently being developed in the US, EU and Japan for fuel efficiency are suited to high power vehicles and come at a cost that is much higher in relation to car prices in emerging economies than in OECD countries. The technology solutions for improving fuel efficiency in the short term are therefore different in emerging economies. Idle stop-start systems offer the most cost effective savings in emerging country conditions, because of the extent of congestion in urban areas[2]. Small electric vehicles with limited range for urban areas might also be suited to conditions in the emerging economies. In the long run, engine downsizing in OECD markets and increasing incomes in developing economies will drive a degree of convergence. Despite the differences in technology, the approach for governments to promote fuel efficiency is universal: fuel economy standards to reduce commercial risk for car manufacturers producing fuel efficient vehicles; complementary tax policy[3] to steer technological improvements towards increasing efficiency rather than power. Regulatory standards can also be designed to discourage up-sizing of the fleet as is the case in China. Fuel tax policy is an important factor and can also influence the pattern of imports of second hand cars, which supply a large part of the market in many developing economies. Ending fuel subsidies is difficult, especially in periods of high fuel prices, but inevitable.

Motorised two and three wheelers are a major part of traffic in many emerging economies, and they are less readily susceptible to the demand management measures discussed for cars below. They are important as they provide essential mobility to families on modest incomes, but they are also the source of serious local air pollution, even if their CO2 emissions are modest. Some Chinese cities limit the number of motorcycle registrations, and the country produces 15 million electric bicycles a year as a locally clean alternative. These nevertheless add to power demand from a coal based, CO2 intensive, electricity industry. In these circumstances an electric bicycle is associated with a similar level of CO2 emissions per km driven on well-to-wheels basis as a good petrol driven motorbike. In India the Tata Nano car is aimed at the more affluent end of the

---

2. These systems are also cost-effective in OECD countries but the largest gains in efficiency in high income countries over the next two decades will come from downsized engines with turbo-chargers.

3. Tax on vehicle ownership and road use differentiated according to fuel efficiency rating.

motorcycle market, with much improved safety compared to transporting families on motorcycles one of its attractions. If it, and similar low cost cars, proves a commercial success it will accelerate the already rapid growth in car fleets in emerging economies.

The freight transport sector is showing rapid growth of road haulage and erosion of the share of rail and waterway traffic. Trucks generally have poor fuel efficiency and emit high levels of air emissions. Reduced diesel tax rates, aligned with tax on kerosene for cooking and heating, should be ended to provide incentives for more fuel efficient vehicles and more efficient logistics organisation. Taxes on imported used vehicles can be differentiated to eliminate the worst performing trucks. For cars, trucks and buses, inspection and maintenance programs have proven effective in reducing air emissions and maintaining design fuel-efficiency.

In rural areas road infrastructure development is driving rapid motorisation of transport. India plans to connect all its villages to all-weather roads by 2012. Carts pulled by animals are often replaced by locally produced, three wheelers. The impact on CO_2 emissions will be significant.

Demand Management

The rapidly expanding cities of the emerging economies pose a major challenge for mitigating CO_2 emissions and present the greatest opportunities for curbing emissions growth. Car ownership is increasing most rapidly in the cities. The pattern of land use determines transport demand, and transport infrastructure development pays a major role in determining land use. Integrated land use and transport planning is therefore critical to shaping transport demand and promoting the kind of compact urban development, served by public transport, that enables large numbers of people access to jobs and services without reliance on the most fuel intensive, CO_2 intensive and polluting kinds of motorised transport.

Land use planning on its own is, however, a relatively weak instrument, vulnerable to the pressures of property speculation, encroachment and squatting. Restrictions on land use may unduly distort property prices, with undesirable allocational and distributional consequences. The main source of income for many local authorities is from leasing land for new development. Land use policies are insufficient to manage demand for road space if road use and parking are free of charge. When road and parking space go un-priced, excess demand is inevitable in densely populated cities with rising incomes. Road pricing and parking charges are not the preserve of OECD countries as the most successful and technologically advanced urban congestion charging system operates in Singapore. It was first introduced as a simple paper permits system for access to the city centre, deployed early in development of the city. It has evolved in scope and technological sophistication to keep pace with rising levels of traffic. A road pricing system was designed for Hong Kong a number of years ago and although not yet implemented this might provide a model for other cities in China. In Latin America a number of major cities are considering introducing urban tolling.

Singapore also manages car ownership by auctioning permits, a system already adopted in Shanghai.

Parking charges, with enforcement of parking regulations, are a much more widely applicable instrument for managing demand for road space, and are quite effective in inducing a modal switch to transit (see section 3). Parking policies proved critical in managing the rapid increase in car ownership in transition economies in Central and Eastern Europe. Some Japanese cities require proof of off road parking space for registering cars and this system might be adopted elsewhere. More generally policy towards parking should be made explicit. Some cities in OECD countries have required new dwellings and offices to be built with off road parking, only to find this encourages car use; others have restricted provision of off-street parking in residential buildings and taxed office parking space in order to discourage car use. Policies need to be consistent to achieve predicable outcomes.

Expertise on demand management resides chiefly in local authorities rather than central government. Overseas development aid from donor countries and the technical assistance programs of international finance institutions should direct resources to making this expertise available to counterparts recipient countries.

Public Transport

In some emerging economies, notably India, rapid urbanisation has been accompanied by a decline in public transport services, exacerbating the expansion of private motorisation. Elsewhere, public transport investments have greatly improved urban mobility and move more passengers per ton of CO2 emitted; Curitiba and Bogota are notable examples of cities that have developed bus rapid transit systems, which are many times cheaper and more flexible than many rail systems. Integrated ticketing systems that facilitate interchange between BRT, local bus and rail systems are effective in promoting use of public transport. The timing of investments in public transport is critical because rising incomes permit an exponential growth in motorised vehicle ownership. Generally the earlier the investment the more successful it will be in managing private road traffic growth. Once a city is dependent on private motorised transport it is difficult to create a market for public transport. International Financial Institutions can play a critical role in funding public transport in the early stages of urban expansion. They can also provide critical technical assistance in establishing sustainable financing frameworks, through fare revenues and subsidies that provide for adequate maintenance of vehicle fleets, without which public transport systems rapidly deteriorate.

The International Financial Institutions can also have a critical role in supporting governments develop the institutional capacity to develop public transport and integrate land use and transport planning more generally. Technical assistance of this sort is more valuable in the long run than overseas development assistance to support investment projects, such as metro systems, linked to exports of technology.

