Transformation of Bus Rapid Transit into Guided Buses:

An Interesting Transit Perspective

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Bus Rapid Transit

Dual-Mode-Bus

Just a word …

This paper is the product of the research that was conducted to:

- Help understand the transformation of Bus Rapid Transit (BRT) into Guided Buses (GB);
- Highlight the expert opinions about the transit solution supported with the successful operations of the BRT systems; and
- Draw attention to a number of GB systems around the world.

The focus of this research was to provide the public transit planners with another prospective which could lead them to an effective, efficient, flexible, and sustainable transit solution for their communities and cities. No attempts were made to include any financial analysis and it was left up to the public transit planners to proceed with the next logical steps in the process of evaluation.

This paper is based on the information available in the public domain and necessary hyperlinks are created to navigate readers to the respective sources where additional information can be accessed.

Mir F. Ali

1. INTRODUCTION

Transportation is responsible for 25 percent of global carbon dioxide (CO_2) emissions. This share is increasing annually in almost every country and transportation emissions are becoming a serious concern for urban centres around the world.

More specifically, cars have a direct impact on the environment in terms of air quality, greenhouse gases, ozone depletion, particulates, toxins, water quality, use of natural resources and noise. CO2 is the most prevalent greenhouse gas (GHG). These air pollutants not only contribute to global warming, they also contribute to a variety of diseases, including cancer, respiratory diseases, and heart failure. The total health impacts of car pollution are difficult to calculate since there are so many different pollutants causing a variety of diseases, and most pollutants have other sources besides cars, however, the number of premature deaths from car pollution appears to be similar in magnitude to the number of deaths resulting from traffic crashes, although the exact amount is difficult to determine.

The good news is that the awareness about the transportation impacts on the environment is growing rapidly and it has influenced the transformation of public transit vision which is evolved from a narrow and restricted focus on moving people and goods from point A to point B without giving any considerations to the potential impact on the surroundings, to a vision which integrates the sensitivity for environment, health, and economy. Accordingly, public transit planners started developing strategies by defining improved transportation choices; incentives shift mode, land use management, and program support activities with the focus on the following objectives:

- Increase mobility and improve accessibility;
- Improve transit operations efficiencies;
- Enhance environmental quality;
- Optimize public investment;
- Support local plans for economic and community development; and
- Contribute to attainment of regional air quality standards.

In order to validate their plans and convince the decision makers, public transit planners started looking into the ways other public transit planners and experts are recommending transit solutions for their cities and communities. Consequently, they appreciated the report that was published on January 15, 2009 by World Resources Institute (WRI) which helped to demystify the hype that was associated with the available options for rapid transit and clearly identified BRT as a viable transit solution.

This paper is dedicated to explaining why Bus Rapid Transit (BRT) is becoming a viable transit solution and how the extended version of BRT, the Guided Buses (GB) transit solutions, are being selected and implemented around the world to take advantage of added benefits including the flexibility to operate those buses in multiple modes.

2. BUS RAPID TRANSIT (BRT)

The most common definition for BRT is a rubber-tired rapid transit service that combines stations, vehicles, running ways, a flexible operating plan, and technology into a high quality, customer focused service that is frequent, fast, reliable, comfortable, and cost efficient.

There are three general types of BRT running ways, each of which has varied configurations:

1. **Exclusive Busways:** This category describes limited access running ways that are generally not used by any other traffic or mode of transportation;
2. **Dedicated Lanes:** These are exclusive transit or high occupancy vehicle (HOV) lanes that are located on existing roadways, but are separated from the regular road lanes in some way; and
3. **Mixed Traffic:** It is possible for BRT services to operate in mixed traffic in cases where dedicated facilities are not required to guarantee reliable operation.

Here are some examples which promote BRT as a viable transit option from a cost as well as environment point of view:

1. World Resources Institute (WRI) has a long history of helping cities worldwide implementing transportation systems. It is a non-partisan environmental think tank which has a goal to promote socially, financially, and environmentally sustainable transportation solutions based on well-informed and participative decision-making processes. With this in mind, WRI submitted its analysis to the Maryland Transit Administration (MTA). It compares Bus Rapid Transit (BRT) and Light Rail Transit (LRT) in the "medium investment" (an alternative that uses the various options that provide maximum benefit relative to cost) range, and confirms that BRT would be more cost-effective and lower-risk. In addition, WRI's analysis confirms that BRT is the only option that would work locally to fight global warming, with a medium-investment system cutting carbon dioxide emissions by almost 9,000 metric tons per year, equivalent to taking about 1,600 cars off the road.

   MTA estimates that medium investment in BRT would require $580 million in capital investment and $17 million in yearly operational costs. In comparison, an equivalent LRT system would cost more than double, requiring $1.2 billion in capital and an annual $25 million for operations.

   The analysis submitted by WRI was for the Purple Line which is proposed by MTA. The Purple Line is a 16-mile rapid transitway extending from Bethesda in Montgomery County to New Carrollton in Prince George's County. It would provide direct connections to the Metrorail Red, Green, and Orange Lines; at Bethesda, Silver Spring, College Park, and New Carrollton. The Purple Line would also connect to MARC, Amtrak, and local bus services. In addition to providing connections to other transit services, the Purple Line would connect the major activity centers in the corridor.

2. Earlier this month, Mexico City received honorable mention at the 2009 Sustainable Transport Awards for its efforts to improve public transit, revitalize public spaces, and create a better quality of life for its residents. It is estimated that Metrobús reduces about 47,000 tons of carbon dioxide emissions from the atmosphere each year which is estimated to be equivalent to 8,355 cars. The city has initiated construction on three additional BRT lines, as well as more bike paths, as part of Mayor Marcelo Ebrard's sustainable transport and development agenda, El Plan Verde ("Green Plan").

   The new 36-station line runs through the city's eastern district of Iztapalapa, serving about 106,000 passengers per day. Average travel time has been reduced to 55 minutes, a nearly 60 percent decrease from before.

   Currently, the entire Metrobús network carries 320,000 passengers per day. With planning and implementation guidance from EMBARQ and CTS-México, Metrobús has improved mobility by 50 percent along the city's heavily congested Avenida de los Insurgentes ("Insurgents' Avenue"), reduced accidents by 30 percent, and encouraged a five percent shift from trips taken in private vehicles to public transport.

3. It was concluded that BRT may be a better transit option to fight global warming than rail transit powered by electricity generated by fossil fuels, according to a new analysis by the Breakthrough Technologies Institute (BTI). Published earlier this year in the Journal of Public Transportation, the analysis - "The Potential for Bus Rapid Transit to reduce transportation related CO2 Emissions" - examines Bus Rapid Transit as a near-term strategy for reducing CO2 emissions in a medium sized U.S. city.

   The analysis is based on a comparison of three scenarios for meeting a typical mid-size city's growth in work trips by 2011 and the anticipated CO2 emissions that would result. Those scenarios include a "no-build" option (relying on private automobiles and the existing diesel bus fleet); a light-rail (LRT) system; and a BRT system using 40- or 60-ft buses with low-emission drivetrains.

4. It is worth mentioning the position that is taken by the Federal Transit Administration (FTA) on the subject. They promote the BRT concept with the slogan, "*think rail, use buses*." BRT combines the quality of rail transit with the flexibility of buses and focuses on speed, comfort and reliability.

   BRT encompasses a variety of approaches, including buses using exclusive busways, buses using High Occupancy Yehicle (HOY) lanes and improving bus service on city arterial streets. A central concept in BRT planning is to give priority to transit vehicles, since on average they carry many more people than other road vehicles. The goal is to maximize person-throughput, not necessarily vehicle-throughput. One form of priority is to run transit service on exclusive rights-of-way such as busways. This technique can greatly reduce in-vehicle travel time for passengers.

5. Institute for Transportation and Development Policy concluded their findings that BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost. A BRT system will typically cost 4 to 20 times less than a tram or LRT system and 10 to 100 times less than a metro system.

   BRT has been found to be one of the most cost-effective mechanisms for cities to rapidly develop a public transport system that can achieve a full network as well as deliver a rapid and high-quality service. While still in its early years of application, the BRT concept offers the potential to revolutionize the manner of urban transport.

The transformation of BRT into GB was another opportunity to further reduce the CO2 emissions and incorporate the flexibility which allows GB to travel on/off tracks.

3. GUIDED BUSES (GB)

GB are defined to be those buses which are steered or guided partially or fully of their route by external means, usually on a dedicated track. This track typically runs parallel to the existing roads, avoiding all other traffic and permitting the maintenance of reliable schedules on heavily used corridors. GB will travel on both, guided busway and also on ordinary roads. Guidance systems can be either physical, such as kerbs, slot, or remote, such as optical/radio guidance.

a. **Kerb-Guided Buses (KGB):**
On KGB, small guide wheels are attached to the bus, and these wheels engage vertical kerbs on either side of the trackway. The bus is steered or guided in the normal way away from the guideway. The start of the guideway is funnelled from a wide track to the normal width. The trackway allows for high-speed operation on a narrow guideway as well as precise positioning at boarding platforms, facilitating access for the elderly and disabled.

b. **Optical Guided Bus (OGB):**
With an Optically Guided Bus (OGB), the guidance is by light sensors (Cameras). Optical guidance relies on the principles of image processing. A camera located in front of the vehicle scans the bands of paint on the ground representing the reference trajectory. The signals obtained by the camera are sent to an onboard computer which combines them with dynamic parameters of the vehicle (speed, yaw rate, wheel angle). Thus, the calculator transmits commands to the guidance motor located on the steering column of the vehicle to control its trajectory in line with that of the reference. However the bus driver can override the steering system at any time should the need arise. There are significant infrastructure benefits if the dedicated channel is not required, and the OGB can be more easily shared with other traffic when not in use.

c. **Slot Guided Bus:**
Slot guided bus systems require a single rail or groove to be embedded in the road surface which is then used to guide buses along their route. Slot guidance systems can

be fully segregated from other road users or can be combined with general traffic in the same way that some tram systems.

Some of the slot guided bus systems in operation also include overhead electricity cables to power the buses e.g. the “rubber tyred tram” in the French towns of Caen and Nancy and the new “Translohr” system which is currently in development and is due to be introduced in several French and Italian towns. Although these systems are essentially electrically powered guided buses they aim to replicate the image and quality of a tram.

The analysis shows that the width of land required for a two-lane guided busway is the same as that is available on a disused two-track railway, less than for a normal two-lane bus-way. This translates into land use savings and means that negotiation of any existing overbridges or underbridges is not an issue for these predominantly off-street schemes.

The physical features of a guide-way also mean that they are self policing, giving them an advantage over traditional bus lanes that are often subject to misuse by other vehicles.

Here are some examples of GB in various countries:

1. **Essen, Germany:**

   Essen's O-Bahn system was part of an experiment in bus transport started in the late 1970's whereby the (West) German Government Federal Ministry of Research and Technology funded a developmental project to perfect two recent German designed innovations in bus transport - the 'self-steering' kerb guided bus and the twin system 'duo-bus' - by means of a phased programme of testing and evaluation over two (later became three) quiet suburban private rights of way which, if successful, could eventually be linked up via the city centre to provide a 'dual-mode-bus' demonstration system.

The rational behind the experiment was that over recent decades Essen, like many other West German cities, had followed a policy of upgrading metre gauge street tramways into standard gauge light railways and in congested city centres relocating both modes into underground tunnel systems. Its buses however remained on the surface, and as might be expected at times of peak traffic flow the delays often caused considerable disruption to services. Having built expensive infrastructure for the steel wheeled transports it was felt desirable to try to maximize the benefits of that expenditure by extending the buses through the tunnels too.

2. Mannheim, Germany:

Apart from Essen the only other German city to have used the kerb guided O-Bahn system was Mannheim, where buses shared a pre-existing surface light rail private right of way. Installed in April 1992 this 800 metre installation helped city-bound vehicles to bypass traffic congestion leading up to a busy traffic signal controlled junction in a location where there was no space for an extra traffic lane. (Out-bound vehicles used the public highway). As the view of two buses at a traffic signal controlled 'level crossing' along the route demonstrates, even though they were buses the tracked vehicles used to receive precedence over other vehicles that wanted to cross the line. The trackage used here consisted of longitudinal wooden beams and steel guidewalls as developed in Essen for where trams and buses share formation. Compared to wooden track in Essen the ride quality of a Mannheim kerb guided bus was considerably better, however Mannheim's track had more and sharper curves which together with the four guide-wheels (one next to each of the front and rear road wheels) gave an impression of almost 'bouncing' between the buses' four corners! In the event the distance was so short (and the already slow moving bus had to slow down even further for the level crossing) so ride quality was not really too important.

3. Adelaide, Australia:

The O-Bahn Busway in the South Australia capital city of Adelaide is the world's longest and fastest guided busway. The O-Bahn was conceived by Daimler-Benz to enable buses to avoid traffic congestion by sharing tram tunnels in the German city of Essen. The route was introduced in 1986 to service Adelaide's rapidly expanding north eastern suburb, replacing an earlier plan for a tramway extension.

The design is unique among public transport systems; Busways typically use dedicated bus lanes or separate carriageways, but the O-Bahn runs on specially-built track, combining elements of both bus and rail systems. The track is 12 kilometres (7.5 mi) long and includes one station and two interchanges, Klemzig Station in Klemzig, Paradise Interchange in Campbelltown, and Tea Tree Plaza Interchange in Tea Tree Gully. Interchanges allow buses to enter and exit the busway and to continue on suburban routes, avoiding the need for passengers to change. Buses travel at a maximum speed of 100 km/h (62 mph), and the busway is capable of carrying 18,000 passengers an hour from the Central Business District to Tea Tree Plaza in 15 minutes. Services are operated by Torrens Transit under contract from Adelaide Metro, an agency of the South Australian Department for Transport, Energy and Infrastructure.

4. Birmingham, England:

The first British line was in Birmingham. Operated by the West Midlands Passenger Transport Executive ('Centro'), it featured six 'passenger stations' which were equipped with shelters, tip-up seats and electronic information displays advising passengers when the next bus would be due. Access to the stops was by ramp, so even though the vehicles were not 'low floor' they were still more easily reached by people with special needs. The busway trackage consisted of a concrete road surface into which steel guide-walls were set, with the centre strip between the bus' wheels 'rough surfaced' to deter cars from using it and overall landscaping designed to deter pedestrians from wandering where they were not wanted. Technically it was treated like any other bus lane, ie: a part of the normal highway that had been made subject to a Traffic Regulation Order restricting access to buses only - in effect this meant that construction and maintenance were the responsibility of the local highway authority, and not the bus operator.

Within the parameters set for it, this experiment was proven successful. Bus patronage on route 65 rose by 29.3% compared to a more modest 4.2% within the West Midlands area as a whole. The guidance system proved both safe and reliable in operation, the initial fears that the protruding guide wheels might prove hazardous - especially to unwary pedestrians - were proven unfounded (although one did snap off when a bus that had been diverted away from its normal routing hit a kerb) and although little now remains of the Birmingham installation much valuable information was gained.

5. Leeds, England:

The guided bus system on Scott Hall Road in Leeds, branded as Superbus, was launched in 1995. Scott Hall Road is a well-defined, radial corridor of dual carriageway status to the north of the city. Bus was not traditionally regarded as a significant mode along the corridor. In contrast with the O-Bahn in Adelaide which uses a continuous guideway along a wholly separate right of way, the Leeds scheme uses a series of relatively short stretches of guideway on or immediately adjacent to an existing road at particular points where traffic congestion occurs. The guideway was completed and opened in sections, the first of which opened for operation in September 1995 and the third and most recent of which opened in 1998.

In the longer term there is an interest in using articulated buses, which being rare in Britain would have a certain 'novelty' image. However they are more expensive to purchase, and at present the priority is to keep frequencies as high as possible. In pursuance of this aim summer 1997 saw an arctic being loaned from the Grampian Regional Transport fleet. This vehicle was an Alexander-bodied Mercedes-Benz 0405G, with the personalised plate of K1 GRT.

Local reaction to the services has been very favourable. Within six weeks of the opening of the guideway bus usage had risen by 9%. Growth continued, and by May 1997 it had risen by a claimed 40% above patronage before the Superbus scheme commenced. Even a fares increase did little to slow the increase in patronage. However, as Dr Tebb (the UK's foremost promoter of kerb guided buses) pointed out, this success is primarily the result of a policy of 'whole corridor enhancement'; guided operation may make the journey a little faster, but equally important is the rest of the 'package', including the special livery, quality vehicle interiors, customer care training for drivers, household distribution of timetables and information, positive media profile, etc. In many ways success in Leeds only reinforces experiences gained in Birmingham and Ipswich.

On 5th November 2001 the second tranche of guided busway opened in Leeds. Marketed under the name of 'elite' and costing about £16 million it features a total of 2.1km of guided busway plus 2.6km of new (unguided) bus lanes on York Road and Selby Road in East Leeds.

For this scheme over 330 bus stops have been reconstructed and 150 shelters replaced, plus all stops rose to 160mm at the kerb to allow easier access on to the dedicated fleet of low-floor easy access buses. The new shelters are modern in design, with internal lighting and a large area of 'transparency' so that waiting passengers can see all around them as well as being seen by others. The roof is also transparent to allow in more daylight. The shelters also feature improved information displays, which are larger and easier to read. As part of the high-profile publicity scheme all new shelters are red and cream in colour and can also be identified by their purple "half-moon" ends and purple timetable cases. The intention is that if passengers see a bus shelter featuring the elite scheme's purple, they can have confidence that it will be served by the new 'elite' buses. In due course it is intended to introduce a 'real time information' system using global positioning satellite technology.

This scheme is also innovative because two competing bus operators (First and ARRIVA Yorkshire) are involved; between them they have invested heavily (£6 million!) in a total of over 40 new 78-seater double-decker buses, enabling passengers to travel in style and comfort. However there are some other bus companies which also provide services over these sections of road and when elite opened they neither invested in new vehicles, nor equipped their existing buses with guide-wheels - which means that they cannot use the new guided busway. This means that in places there are two sets of bus stops for buses travelling in the same direction - one each on and off the guideway. It remains to be seen whether they find it commercially desirable to fit guide-wheels to their buses.

6. Bradford, England:

Hot on the heels of the opening of Leeds's second guided busway another Yorkshire city has opened its first installation. This was on the 31st January 2002 and is in nearby Bradford. Here there are five sections totalling 2.3km (1½) of guided busway which form part of a 3.7km *Quality Bus Initiative* along the A641 Manchester Road. This installation includes 11 new traffic light-controlled pedestrian crossings, new footpaths, seats, plus major landscaping which has seen the planting of thousands of bulbs and shrubs and scores of trees.

Perversely the opening of the Bradford guided busway was accompanied by a 25% reduction in the parallel road's speed limit from 65km/h - 50km/h.

7. Sussex, England:

In September 2003 the first stage of the planned 24km Sussex "Fastway" scheme opened. At first information sources suggested that when complete this system would feature 2.5km of guided busway plus 9km of ordinary busway on services linking Gatwick Airport with the nearby towns of Crawley and Horley. However, in the event this became 1.5km of guided busway and 5.8km of normal busway.

This is the first use of kerb guidance as part of a regional transport system which serves multiple towns rather than just one major city and its suburbs. Construction began in May 2002, and was scheduled to be completed by 'early 2005' - although timetables slipped with construction works being halted in October 2006.

The Fastway project is promoted and funded by a Public-Private Partnership. The consortium includes West Sussex County Council, Surrey County Council, Crawley Borough Council, Reigate and Banstead Borough Council, BAA (British Airports Authority) Gatwick, British Airways, Metrobus and the Go-Ahead Group. There is also support from the UK Department for Transport, who has provided funding of £16.6m towards the anticipated total scheme cost of £28.9m. This includes an extra £3m after the 2003 decision by the Go-Ahead Group to withdraw its financial commitment to the project following the reduction in the anticipated length of its rail franchise.

Since Fastway first opened Metrobus, the bus operator, has stated that passenger figures are up 10%, with 35% of all journeys being to and from the airport at Gatwick. On average it is carrying 7000 passengers a day, with one million passengers having been carried in the first seven months of operation. It has also indicated that delays have been reduced by the new bus lanes and bus gate.

8. Edinburgh, Scotland:

5th December 2004 saw the opening of the West Edinburgh Busways (WEBS) "Fastlink" busway scheme. Comprising of 1.5km of two-lane dedicated kerb guided busway, this was the first kerb guided busway in Scotland and at the time it featured the longest section of continuous guideway in the UK. Also featuring 3.45km of on-street bus lanes this £10m scheme also included CCTV surveillance, other bus priority measures, upgrades to existing bus stops and road widening to accommodate one of the new bus lanes. Fastlink was located on an 8km bus corridor which stretched from Edinburgh city centre to Edinburgh Park.

One of the primary motivating factors in the construction of Fastlink was that it would allow buses to 'congestion bust' by bypassing queues on the approaches to two major roundabouts between Edinburgh Park and the city centre.

The guided section of Fastlink featured four bus halts; elsewhere along the system some bus stops were improved to allow buses to pull-in closer to the kerb. This was done so as to permit easier boarding and alighting for all passengers, especially those with mobility difficulties and those with pushchairs. A number of existing bus shelters along the Fastlink corridor were also upgraded.

Together with the guideway and bus lanes, parking and loading restrictions were introduced to improve the overall performance of Fastlink and to ensure that passengers get maximum benefit.

30 new buses were bought by Lothian Buses at a cost of £4m, which along with 20 existing buses provided a dedicated service for Fastlink. Each of these buses was fitted with rubber wheeled guide-arms that allowed them to travel along the guideway section. These guide arms (which did not retract) extended to a maximum of 75mm (3") from the side of buses. Two bus routes used the Fastlink guided busway - Lothian Service routes 2 (using double deck buses) and 22 (using single deck buses).

9. Nagoya, Japan:

The Japanese also have some kerb guided busways. The only fully operational installation is a single 6.5 km line in Nagoya, Aichi which opened on 23rd March 2001. This is served by five bus routes which are operated by three different bus companies. Away from the guided section the buses use the normal roadway. As with the many Japanese monorails or automated guideway transits the line is legally considered as a sort of railway.

The other Japanese systems are more experimental in nature:

- One of these is very similar to the O-Bahn, except that the kerbs are wider apart so both sides of the bus cannot make contact at the same time (apparently the vehicles are fitted with a stabiliser to improve straight travel stability) and the guide wheels can be retracted when the vehicle is operating on the normal road. This system has also been tested with bi-directional single track running, using automated signalling systems to only allow one vehicle on a section of track at a time. (Similar signalling systems are commonplace on single-track railways).

  Another feature of this system is that the vehicle's have two guide-wheels by each rear road-wheel (one each in front/behind). The sole purpose of these extra 'touch wheels' is for protection in case of sideways sliding, on snow, ice or in windy weather; and

- The other experimental system is in many ways a 'next stage' advance. While in guided mode it features fully automated driverless operation - so in addition to the block signalling (used for safety) the computers will literally 'drive' the buses - stopping at stations, opening/closing the doors, selecting the route (the system allows for junctions and route bifurcations) etc,. It uses electric buses which are fitted with storage batteries for use on the normal road; in guided mode power is collected by means of a terminal which extends sideways from the rear of the vehicle and contacts a power rail located alongside the track just above a guide rail. (Guided mode also sees recharging of the vehicles' on-board batteries). This power collection system makes an interesting alternative to 'overhead wire' systems (ie: trolleybuses) except that it would not be safe to use in the street environment.

10. Rouen, France:

The French Guided Bus System called Rouen Guided Bus. The east-west axis of the Rouen transport network (TEOR) uses articulated vehicles equipped with an optical guidance system. This is the first commercial application of the system developed by MATRA (now Siemens), which aligns the bus exactly with the edge of the platform so that the driver is free to concentrate on the speed of the bus and the passengers waiting on the platform.

The initial studies were done in 1996. The implementation phase began in 1999. Two western lines were launched in 2001 and the third line was added in 2002. The following phases of the project were concluded in 2007. This system serves a total of 25 kilometres with 41 stations and the daily volume of traffic is 49,000 passengers.

11. Cambridgeshire, England:

Cambridgeshire County Council is in the process of building the longest guided busway in the world. When it opens in late summer 2009 the Guided Busway will provide a reliable, fast and frequent service, a genuine public transport alternative to driving in to Cambridge on the busy A14.

It is expected that the instigation of this project will eventually reduce traffic on the overcrowded A14 by 2.6%.

The Cambridgeshire Guided Bus system will provide 26km of segregated bus route between St. Ives and the northern fringe of Cambridge, linking the proposed new settlement at Northstowe to the employment centre at the Science Park and Cambridge Regional College.

The first new buses that will run on the guideway have been ordered. The majority of new buses will have:

- Wi-fi, a wireless connection to the internet;
- Leather seats;
- Air-chill or air-conditioning;
- Double glazing; and
- Real-time information.

The buses will produce up to 80% less carbon emission than standard buses used at the moment in Cambridge. Stagecoach's buses will also run on 100% bio-diesel instead of using standard diesel.

Here are some facts about the Cambridgeshire guided buses operations:

- The Guided Busway will be the world's longest guided busway at 25.1km long. (The world's second longest busway is in Adelaide. The Adelaide O-Bahn is 12km long.) The northern section is 20.6km and the southern section is 4.5km;
- Within 10 years of opening more than 20,000 trips a day will be made on the busway. In the first year of opening nearly 11,500 trips a day will be made;
- The new Park & Ride at St Ives will have 500 spaces with room to extend to 1000 and the new Park & Ride at Longstanton will have 350 spaces with room to extend to 700;
- Services will operate on the busway from 6am to midnight;
- The Guided Busway will provide local people along the route with a "turn up and go" service. People will be able to arrive at a stop on the guideway and get on a bus within 10 minutes during peak times;
- Two bus companies will run services on the guideway;
- There will be 14 stops on the Guided Busway: St Ives P&R, Fen Drayton Nature Reserve, Swavesey, Longstanton P&R, Oakington, Histon & Impington, Arbury

Park (2), Cambridge Regional College, Science Park, Cambridge railway station, Addenbrooke's hospital, Trumpington and Trumpington P&R; and

- A new bridleway will be built next to the busway for walkers, cyclists and horse-riders to access the Cambridgeshire countryside.

The budget for the Guided Busway includes all expenditure on procurement, surveys and design since 2004. The expenditure to date is:

Original Budget	Previous Years	2007/08	2008/09	Total
£116,272,223	£19,220,284	£37,678,170	£20,689,727	£77,588,181

The bus solution was chosen as it was found to be around a fifth of the cost of constructing a similar light or heavy rail project."

The Cambridgeshire listed the following reasons why the busway is guided rather than a bus-only road:

- A guideway requires less land than a normal road. Because buses travelling in opposite directions are constrained within the two kerbs of the guideway, they can travel close together. Therefore the total width of the guideway is less than a standard road. This means we spend less money on land purchase and also have a lesser impact on the environment;
- A guideway is better in terms of drainage than a solid tarmac road, as water can drain away between the guideway beams;
- A bus only road would need to have stringent measures to stop other vehicles travelling on it. The guideway will be unsuitable for other vehicles;
- The smoothness of guideway provides higher ride quality for passengers and a greater ability for level boarding; and
- Studies have shown that the level of use is greater than that for bus lanes or bus-only roads.

Please click the following link to see a video of the Cambridgeshire Guided Busway.

http://www.youtube.com/watch?v=qC5t08-UY8Y

4. CONCLUSION

Perhaps the most attractive feature of a GB system is considered to be its flexibility in operations. A guided bus can travel on a guideway where it is available but can also travel on any other part of the road network as required.

One of the published studies indicates that in contrast to LRT, distributed access to the guided bus corridor can be provided easily in outer suburbs using the same vehicles. They are also very flexible in that guidance need only be provided where and when traffic conditions deem it appropriate. For example, guideways may be constructed at particular congestion 'hot spots' to allow suitably equipped buses to enter the guideway, advance to the front of a traffic queue, and then leave the guideway to re-enter the main traffic stream. This allows for incremental implementation, whereby self-contained, perhaps relatively short, sections of guideway may be constructed ready for use by suitably equipped vehicles straight away, rather than having to wait for a network of guideways to be constructed. This means that benefits can start occurring early on in the process. It also means that, as congestion becomes worse, or as it changes its location, new sections of guideway may be added relatively easily.

Some guided buses are available with diesel and electric dual-power systems. This means that the diesel engine can be used out of town to power the vehicle and charge up the batteries. Once in town the vehicle can run on its electric motor to reduce environmental impact by running quietly and pollution free.

There are all kind of indications that KGB systems will be adapted around the world simply because of its effectiveness, efficiency, and flexibility. These attributes are really helping the public transit planners to make a case for further reductions in the CO2 emissions as a result of selecting and implementing the GB system for their cities and communities.

Please click the following link to see the "Dual-Mode-Buses":

http://www.youtube.com/watch?v=CTArxcg0Nik

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