

# The Urban Bus – BRT Continuum



# Federal Transit Administration

Annual New Starts Report to Congress – FY 2006  
Full Funding Grant Agreements

	LRT*	BRT**
Total Cost (Billions)	\$6.21	\$0.168
Average Cost Per Project	\$1.035	\$0.168
Projected Weekday Boardings (Average)	27,900	39,000
Average Cost Per Boarding	<b>\$37,100</b>	<b>\$4,308</b>

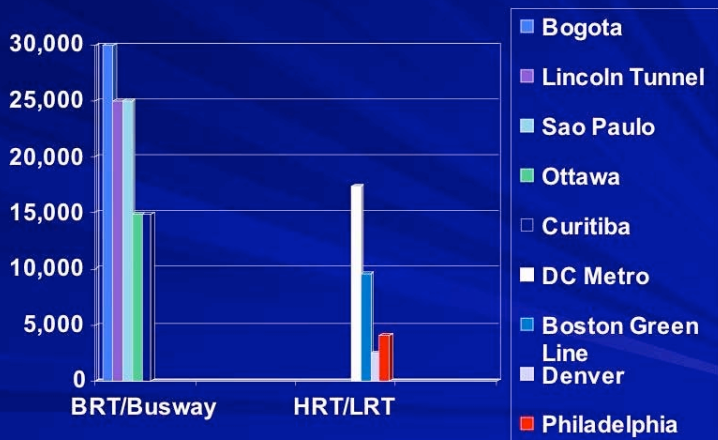
\*Projects: LA Gold Line, San Diego, Denver, New Jersey, Portland, Seattle

\*\* Project: Cleveland

# Which is the BRT?



## Actual Per Hour Passenger Volumes (Peak Direction, Maximum Load Point)



Sources: Transportation Research Board; Transmilenio, S.A.; DMJM and Harris; WMATA; Denver RTD

# Capital Costs

■ BRT:	
■ *Arterial Bus Fclts. (3 Cors., 2 cities)	\$ .68m/Mi.
■ *HOV Facilities (8 corridors, 5 cities)	\$ 8.97m/Mi.
■ *Busways (9 corridors, 4 cities)	\$13.49m/Mi.
■ Rouen TEOR (3 corridors)	\$11.00 m/Mi.**
■ Brisbane SE Busway	\$19.00 m/Mi.
■ Silver Line Phase I	\$25.00 m/Mi.**
■ Cleveland (Euclid Corridor)	\$25.00 m/Mi. ****
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■ *LRT (18 corridors, 13 cities)	\$34.79m/Mi.**
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■ *** HRT (Dulles Corridor)	\$167 million/Mi.

- \*U.S. General Accounting Office Report, "Bus Rapid Transit Shows Promise," 9/2001; Year 2000 \$ U.S.
- \*\*Includes Vehicles
- \*\*\* Virginia Department of Rail and Public Transportation
- \*\*\*\* Includes complete street reconstruction

## Los Angeles Rapid bus vs. LRT

	Rapid Bus (Wilshire)	LRT (Gold Line)
Cost/km	\$120 thousand	\$38 million
Weekday Boardings	50 thousand	15 thousand
Average speed	22.5 – 48 km/h	37 km/h
Ridership	+42%	-60% (below projections)

Sources: LACMTA, FTA, LA Times

## Pittsburgh Busway vs. LRT

	Busways (3 exclusive)	LRT
Length	29.8 km	40.2 km
Total Cost	\$468 million	\$937 million
Cost/km	\$15.7 million	\$23.3 million (reconstruction)
Weekday Boardings	51 thousand	24 thousand

Sources: Port Authority of Allegheny County; FTA

## Adjusted Operating Costs Per Vehicle Hour

City	Rapid Bus	LRT
Sacramento	\$161.62	\$177.23
San Jose	\$217.69	\$233.61
San Diego	\$108.00	\$ 97.62
Portland	\$143.17	\$141.60
St. Louis	\$161.46	\$193.20
Dallas	\$170.89	\$214.90
LACMTA	\$172.40	\$313.20

Adjusted for vehicle capacity, Av. # seats+ standees @ 3/Mtr<sup>2</sup>

Source: DMJM&Harris  
FTA, National Transit Database, 2000

Note: Bus costs are regional averages and include vehicle O/M and Admin.; LRT numbers cover all O/M activities

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## Ridership Gains

People choose to ride enhanced bus service instead of drive.

- Houston: 18% to 30% of riders were new riders
- Los Angeles: 40% gain in riders, one-third of which were new;
- Vancouver: 8,000 new riders, 20% of whom previously used automobiles;
- Adelaide: 76% gain in ridership;
- Brisbane: 42% gain in ridership;
- Leeds: 50% gain in ridership;
- Pittsburgh: 38% gain in ridership.

Source: TCRP-90, Transportation Research Board; LACMTA

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# Forcing Bus-Rail Transfers Can be a Bad Idea

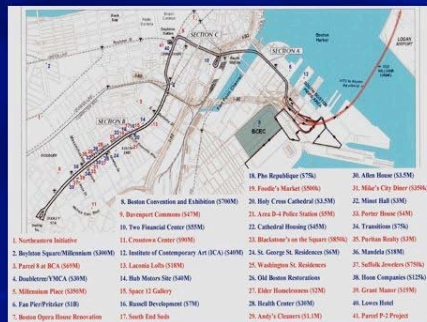
## ■ Houston

– Ridership declined significantly on most routes

- 2 Bellaire: Down 16%
- 4 Beechnut: Down 30%
- 14 Hiram Clarke: Down 50%
- 66 Yale: Down 41%
- 132 Harwin Express: Down 25%
- 170 Missouri City Express: Down 24%
- 6 Jensen: Up 31%
- 15 Fulton: Up 34%
- 65 Bissonnet: Up 2%

– Source: Houston Chronicle

# Transit-Oriented Development



**\$500 M Worth of Projects Along Boston's Silver Line  
Since Construction Began**

*Breakthrough Technologies Institute*

# Transit-oriented development Ottawa



St. Laurent Mall: Highest Grossing  
per Sq. Ft. in Ottawa



# Transit-Oriented Development Brisbane

## Busway boosts house values

**Joel Dalrymple**

Queensland research shows suburbs with direct access to the busway's stations had sold growth over the recent quarter. "Most other suburbs next door to these busway suburbs also performed well however they did record percentage changes slightly below those near the busway," REIQ president Mark Brimble said.

The most outstanding jump was in Holland Park West, where values rose 26.86 per cent. The neighbouring suburb of Holland Park, which does not have direct busway access, rose 6.23 per cent.

The comparisons showed busway suburbs were performing above city-wide increases which have seen nearly all areas value down of the QBR improve in value.

Other neighbouring suburbs that did not perform as well include Mount Gravatt East, which recorded a 3.38 per cent coup with 8.29 per cent in the busway suburb of Mount Stirling, and Bayside, which increased by 1.56 per cent compared with a jump of 1.39 per cent in busway suburb Right Mile Plains.

"This research supports the trend that more people are moving to areas within five to 10km of the QBR which are close to convenient public transport such as the busway," Mr Brimble said.

Queensland Transport recorded a "blowout boom" on the busway with a 49 per cent growth in passenger figures in its first six months, or about 18,000 passenger trips a day.

The figures also showed approximately 375,000 private vehicle trips were converted to public transport along the busway, which straddles the South East Freeway.

Property values also would increase if proposed extensions of the busway along northern and eastern routes went ahead, analysis said.

National Property Research analyst Matthew Cross said areas near public transport nodes would nearly always rise in value.

"Historically, housing is always followed public transport nodes. These close to transport generally have high values," Mr Cross said.

A lot of investor stock in rental properties are considered worth more if they are close to public transport because they are easier to rent.

The \$135 million Inner North Brisbane Busway is nearing completion, and the planned dedicated bus lanes will go passenger uninterrupted travel as far as Kedron.

Source: Brisbane Courier Mail, 1/26/02

# Transit-Oriented Development Brisbane



# Bus Rapid Transit: The US Experience

*Bill Vincent*

*Breakthrough Technologies Institute*

*November 2004*

## Abstract

Bus Rapid Transit (BRT) is a relatively new concept in the United States and is rapidly gaining in popularity. In 1998, the Federal Transit Administration started a program to encourage communities to invest in BRT. Today, a number of cities have begun developing BRT systems, while others are actively considering BRT investments. At the same time, recent research shows that BRT can meet or achieve the capacity and economic development potential of rail, but at a fraction of the cost.

Despite these successes, challenges remain for further BRT deployment in the United States. Communities often view rail as superior to BRT and thus demand new rail systems. Government policies tend to reflect this preference by favoring investments in rail.

As BRT continues to prove successful, interest in the technology will continue to grow. The challenge will be to ensure that BRT is evaluated on a level playing field with other technologies.

The challenge is beginning to be met. For example, changes have been proposed in federal law that would make it easier for communities to invest in BRT. These proposals have been introduced in Congress.

Moreover, some of the first BRT systems in the US are showing positive results. These results are being noticed by policy makers and transport advocates, increasing the level of interest in BRT.

## Introduction

Traffic congestion and air quality continue to plague US cities. Despite massive investments in new highway and rail transit infrastructure, the problems continue to grow worse.

BRT provides a cost-effective transit alternative to help improve air quality and reduce congestion. A system generally is considered to be BRT if it includes the following features:

- Dedicated right of way
- Rail-like stations
- Low floor, low emission vehicles
- Off-vehicle fare collection
- Frequent, all day service
- Intuitive, well-designed route structure, and
- Intelligent Transportation System (ITS) technology
- Multimodal access, including feeder services and bicycle and pedestrian access.

Currently, there are no US BRT systems that contain all of these features. There are, however, a number of systems that contain some of these elements. These systems are more accurately described as “rapid bus,” not BRT. However, full-featured BRT systems are under development and will be deployed before the end of this decade.

This paper provides an overview of several current rapid bus projects. It examines three general categories: systems that operate on arterial streets, systems that use dedicated rights-of-way, and systems that use both streets and dedicated rights-of-way.

## Arterial Street Rapid Bus -- Los Angeles

Los Angeles has one of the best examples in the US of a low cost and highly effective rapid bus system. This system currently is in Phase I of what ultimately will become a BRT network covering over 550 kilometers.



**Future Metro Rapid network.**

Known as Metro Rapid, the system carries over 110,000 passengers per day on seven rapid bus corridors. The most successful corridor, Wilshire Boulevard, carries 45,000 passengers per day.

Currently, Metro Rapid uses 40-foot, low floor, compressed natural gas buses. Larger, articulated buses have been purchased, however, substantially increasing the capacity of the system.



**Future Metro Rapid CNG Bus**

During peak hours, buses on the Wilshire line depart every 90 seconds. There are 30 stations spaced about a mile apart. The stations provide shelter and have real-time passenger information systems. Phase II of the project will include fare collection in the station.



**Metro Rapid station**

Metro Rapid currently operates in mixed traffic. However, Phase II of the project will include dedicated lanes. There currently is a dedicated lane being tested on Wilshire Boulevard.

A signal priority system forces traffic lights to remain green as vehicles approach. There also is a central control facility that helps regulate the flow of buses.

Metro Rapid is having a significant impact on air quality and congestion. Weekday ridership in the Wilshire Corridor is up 42%. One-third of this increase is people who never rode transit before. The remainder of the increase is current riders riding more often, or current riders who changed routes to take Metro Rapid. Travel times have been reduced by 29% and current average speeds are around 15 miles per hour during peak and as high as 30 miles per hour during non-peak.



**Wilshire Boulevard shows that BRT can be successful in a dense urban environment.**

Phase I of Metro Rapid has clearly shown that relatively small investments can yield tremendous benefits. Capital investment in the Wilshire corridor was roughly \$200 thousand per mile: \$100 thousand for stations and \$100 thousand for signal priority. By contrast, a rail investment in the same corridor could easily cost \$50-100 million per mile or more.

## Dedicated Right-of-Way

### *Pittsburgh*

Pittsburgh, Pennsylvania, has been using dedicated busways for over 25 years. The city has 18.5 miles of dedicated bus lanes on three routes – the East, West, and South Busways. These busways have 51,000 weekday boardings combined.



**Map of Pittsburgh Busway System (Port Authority of Allegheny County)**

The system began with the 4.3-mile South Busway, which opened for service in 1977. Sixteen express and local routes use the busway, and there are eight stops on the system. An interesting feature of the South Busway is that it shares a tunnel with Pittsburgh's light rail system, known as the "T". The busway has an average weekday ridership of 11,000 passengers.

The East Busway opened in 1983. This is a 6.8-mile, two-lane roadway constructed adjacent to an operating railroad right-of-way. In June 2003, a 2.3 mile, four station extension was opened.

Like the South Busway, the East Busway connects downtown Pittsburgh with suburban neighborhoods. Thirty-six routes offer express and local bus service along the busway. Six busway stations are within walking distance to residential, retail, and entertainment centers. The busway averages

nearly 30,000 weekday riders.



**Pittsburgh's East Busway**

The most recent busway is the five mile West Busway, which opened in 2000. There are six stations and several park and ride facilities, attracting 10,000 weekday riders.

Although Pittsburgh's busway system generally is considered successful, it does not have level-boarding, advance fare collection, rail-like stations, or ITS technologies. Moreover, because of Pittsburgh's mountainous terrain, it was a relatively expensive system, costing an average of \$43 million per mile, which is significantly more than most other bus-based systems in the world.

### *South Miami-Dade Busway*

The South Miami-Dade Busway is an 8.2 mile dedicated busway that connects with Miami's rail system. Both full-size buses and minibuses operate on the busway, offering a combination of express and local service.



**Computer-generated image of a Miami-Dade busway station.**

The busway has fifteen stations in each direction. Each station contains maps, schedules, and public phones. There is a bicycle path that runs along the length of the

busway.

The busway was built in the center of a former rail right-of-way, which is 100 feet wide. The bus lanes are in the middle of this right-of-way and are 12 feet wide, separated by a 4-foot striped median.

Ten local and limited stop routes operate along the busway. Feeder buses circulate through adjacent neighborhoods and connect with the busway. During peak hours, up to 20 buses operate per direction, per hour.

The busway attracts about 12,000 weekday riders. Since opening in 1997, boardings have increased by 71% on weekdays and 130% on weekends.

Construction is under way on an 11.5 mile extension of the busway. The extension will include twelve bus bays and bus shelters and five park and ride lots. The extension is scheduled to open in 2005.

Like Pittsburgh, the Miami-Dade busway is not a full-featured BRT system. For example, even though the busway itself is a dedicated right-of-way, there are sixteen major intersections crossing the route. Buses often stop at the signals, significantly reducing travel speeds.<sup>1</sup> Moreover, the busway does not contain other BRT features, like level-boarding, real-time passenger information systems, and advance fare collection.

Unlike Pittsburgh, the Miami-Dade busway was built on flat terrain that did not require tunnels or other major construction. Thus, the capital costs were much lower – roughly \$7.2 million per mile.

### **Combination Dedicated Right-of-Way and Arterial Street – Boston’s Silver Line**

In Boston, a BRT system is being implemented that, from the beginning, combines substantial elements of dedicated right-of-way and arterial street design. When completed in 2010, it also will be one of the

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<sup>1</sup> It is interesting to note that the Miami-Dade busway originally included a traffic signal priority system, but this system was removed because of safety concerns at the intersections.

first US BRT system that combines all of the features necessary to be a true BRT system.

Known as the Silver Line, this system will be an extension of Boston’s heavy rail network. It will connect downtown Boston with Boston’s train station and airport. Some of the dedicated portion of the right-of-way will be underground through a tunnel.

### **The Silver Line will use a mile-long underground transitway, currently under construction.**

The Silver Line is projected to carry 60,000 passengers per day, which is more than some heavy rail lines. It is being constructed in phases, and the first phase opened in 2002. This phase has been very successful, nearly doubling daily ridership compared with bus services that previously operated in the corridor.

The Silver Line operates 40-foot, low floor, CNG buses. In the future, 60-foot articulated buses will be used. These buses will depart every 2 minutes during peak hours. Moreover, these buses will convert to overhead electric power while operating in tunnels.



**Arterial portion of the Silver Line uses curb-side lanes with significant improvements to the sidewalks and curbs to accommodate the stations.**

The Silver Line will use a GPS-based ITS system to track bus locations along the route. Information will be provided to customers via “smart kiosks” that provide real-time schedule information, digital message boards, intercom assistance, emergency alarms, and an automatic public address system.

### **What Have We Learned?**

The US experience shows that BRT provides a viable and cost-effective strategy to reduce traffic congestion, improve air quality, and enhance mobility. The evidence shows that it can attract people who otherwise would use private automobiles. Moreover, with low emission technology, BRT can be less polluting than electric rail systems, particularly where the electricity is generated from coal.<sup>2</sup>

Despite its many benefits and cost advantages, there are obstacles to BRT implementation in the US. The public frequently views bus service as slow, polluting, and unreliable, making communities hesitant to consider BRT.

At the same time, there are policies and procedures that favor building rail transit over bus transit. For example, federal law currently favors investments in rail, despite the cost and other advantages of BRT. The Federal Transit Administration proposed fixing this, but Congress did not act upon the proposal.

Moreover, in most parts of the country, streets and highways are controlled by one agency, while transit service is controlled by a separate agency. This means that a successful BRT project must have the cooperation of multiple government agencies, none of which are fully accountable for the project.

By contrast, because rail systems operate in their own, exclusive right of way, they generally involve fewer agencies. This reduces the complexity of planning and implementation.

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<sup>2</sup> See *The Electric Rail Dilemma: Clean Transportation from Dirty Electricity?* Breakthrough Technologies Institute (2003) (available at [www.gobrt.org](http://www.gobrt.org)).

Finally, there is a relatively well-organized rail lobby. For some, the higher cost of rail is an opportunity to make a profit or to attract a large federal grant. For others, rail offers perceived prestige or other advantages over bus-based systems.

The following are some ways to ensure that communities make the best possible transportation investment and to ensure that BRT opportunities are fully considered.

First, there must be an objective process that openly assesses technology options to meet a specific transportation goal. Too often, the transportation planning process begins with a specific technology goal, such as building a rail system, then proceeds to justify achieving that goal. The result can be spending far too much to achieve far too little.

Second, if BRT is a serious option, planners should consider incremental development as opposed to building a large BRT project all at one time. Once people see that the first phase of the project is working, it will be much easier to gain support to expand the project.

Third, it is important to consider existing or planned road improvements as opportunities for BRT. HOV lanes are one example. Another possibility are High Occupancy Toll (HOT) lanes. HOT lanes can provide a revenue source to support BRT service.

Fourth, with any significant transit investment, it is important to integrate land use and transportation planning. This will help improve ridership and maximize value for the system. It also is important to provide robust pedestrian and bicycle access.

Fifth, if BRT is a serious option, it is important to ensure that the system is as full-featured as possible. BRT is a family of technologies working together. If some of these technologies are taken away, performance will deteriorate.

Sixth, obtain potential rights-of-way as soon as possible. Once an adequate right-of-way is secured, the planning process becomes much easier. If the right-of-way is on an arterial street, carefully consider whether it will be in

the median or along the curbs. A median right-of-way generally will increase travel time and reduce encroachment by general traffic. However, a median right-of-way generally requires more space to accommodate the stations and other system components.

Finally, plan carefully for intersections between the right-of-way and existing cross streets. The Metro Rapid project has been successful largely because the local transit and street agencies worked together to change traffic signals, thus enabling buses to extend green lights without seriously impacting the traffic on the cross street.

### **Conclusion**

BRT has an extremely promising future in the US. It offers congestion relief and air quality benefits at fraction of the cost of electric rail. It also can offer all of the amenities of rail, thus helping to attract and retain riders.

To ensure its success, local governments and communities must be educated about its benefits. At the same time, policies must be implemented to ensure that the planning process is able to assess all technologies in a neutral and unbiased manner. This will ensure that the best technology is selected to meet the particular needs of the community.

### **About BTI**

Based in Washington, DC, the Breakthrough Technologies Institute is a not-for-profit organization dedicated to promoting advanced environmental and energy technologies. Among other things, BTI is a leading voice on hydrogen and fuel cells, air pollution policy, and innovative transit technologies. BTI's work on BRT was made possible by a grant from the Blue Moon Fund.

### **References**

*Characteristics of Bus Rapid Transit for Decision Making*, US Federal Transit Administration (October 2004)(available at [www.gobrt.org](http://www.gobrt.org)).

*TCRP Report 90, Bus Rapid Transit, Volume 1: Case Studies in Bus Rapid Transit*, National

Academies of Science, Transportation Research Board (2003) (available at [www.gobrt.org](http://www.gobrt.org)).

Jarzad, Lightbody, and Maeda, *Characteristics of Bus Rapid Transit Projects: An Overview*, Journal of Public Transportation, Volume 5, No.2 (2002)

Levinson, Zimmerman, Clinger, Rutherford, *Bus Rapid Transit: An Overview*, Journal of Public Transportation, Volume 5, No.2 (2002)

Bus Rapid Transit Policy Center ([www.gobrt.org](http://www.gobrt.org))

US Federal Transit Administration, Bus Rapid Transit Demonstration Program ([www.fta.dot.gov/brt/](http://www.fta.dot.gov/brt/))

Los Angeles County Metropolitan Transportation Authority, *Wilshire BRT – More Than Just a Dedicated Lane* (2003) (Power Point Presentation)

Boston Silver Line Project Web Site ([www.allaboutsilverline.com](http://www.allaboutsilverline.com))

Miami-Dade Busway Project Construction Web Site ([www.buswayconstruction.com](http://www.buswayconstruction.com))

Port Authority of Allegheny County ([www.ridegold.com/default.asp](http://www.ridegold.com/default.asp))