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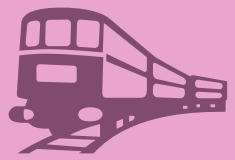

ENHANCING INFRASTRUCTURE

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SUSTAINABLE MODES

Increasing transit capacity, extending the reach of the city's transit network and providing new transit options to New Yorkers are some of the prime transportation goals outlined in PlaNYC 2030. These challenges are particularly pressing in New York City, where there is limited available space and where existing density and logistical challenges drive up construction costs. The best practices featured in this section are modes of transportation that could be implemented in New York City to reduce pressure on existing modes, increase the connectivity and capacity of our public transit system, and take into account rising and fluctuating fuel and oil prices. They represent innovative sustainable planning—environmental, transportation and economic—and may be able to help increase transit capacity with less extensive capital projects.

This report highlights three modes of transportation and/or technologies that have increased the capacities of public transit systems around the world and can reduce traffic congestion and pollution here in New York.

- Hybrid Ferries
  - » Case Study 1: The Solar Sailor
- Bicycle Share Programs
  - » Case Study 2: Bicing & Velib'
- Passenger, Freight & Aerial Streetcars
  - » Case Study 3: The Portland Streetcar
  - » Case Study 4: The CarGo Tram
  - » Case Study 5: Schwebebahn, SkyBus & AeroBus

Rush hour in Manhattan.
Image source: Pete Biggs

HYBRID FERRIES:

New York's island geography makes ferry service an obvious transportation option. However, insufficient waterfront access for pedestrians, poor connections to other modes, high operating costs and air pollution by conventional diesel ferries, have limited the use of ferries in the city. In recent years however, hybrid technologies have become available for ferries, tugboats and other maritime vessels. In addition to decreasing operating costs, hybrid maritime technologies could solve many environmental concerns that deter ferry use including air pollution from diesel emissions, noise pollution and community concerns about ferry landing placement.

This report focuses on the Solar Sailor, a solar-electric-diesel-wind hybrid that is at the forefront of hybrid maritime technology. The Solar Sailor is in operation in Sydney, Australia and proposed by Hornblower Cruises for San Francisco starting in 2009. Solar Sailor was also proposed by Circle Line Downtown for its Statue of Liberty route which has since been awarded by the National Parks Service to Hornblower Cruises. (As of the printing of this report, there has been no indication as to whether Hornblower will consider a Solar Sailor vessel for its New York route.)

Background:

Despite an eratic history, ferry service is part of the daily lives of many New Yorkers. 65,000 people ride the Staten Island Ferry each day.[1] Reports from the city's community boards indicate that ferries are increasingly seen as a desirable transportation mode.[2] However, poor access to the city's waterfronts and the pollution created by conventional, diesel ferries have limited the growth of ferry service in New York.

The sole transportation mode between Manhattan and Brooklyn in the 1800's, ferry service in New York City declined throughout the 1900's due to the construction of the city's bridges and tunnels. Highway construction along the waterfront in the 1930's-1960's further separated New Yorkers from historical ferry landings. The revitalization of New York's waterfronts as recreational areas helped spur a new generation of ferry services (NY Waterways, WaterTaxi for example) in the 1980's and 1990's but access remained limited. In the months following 9/11 ferry service grew quickly providing service across the Hudson River. However most ferry landings were difficult to reach, and the majority of commuters returned to their pre-9/11 transportation modes as soon as they became available.

The pollution created by conventional, diesel ferries has also limited their potential in cities like New York. Diesel ferries produce significant amounts of air pollution and noise, especially when idling at dock. Diesel emission are composed of gases and solids such as nitrogen oxides (NOx), which contribute to ozone production and particulate matter or soot (PM), and pose severe respiratory health risks.[3] As result, many residential communities do not want ferry landings in their midst, further limiting access points.

Addressing these pollution issues can be done through retrofits to conventional diesel ferries and through phasing in hybrid ferry technology. The Port Authority of NY/NJ, in collaboration with the US Environmental Protection Agency, NYCDOT and the US Army Corps of Engineers, has worked to reduce the diesel emissions from the Staten Island Ferry by installing selective catalytic reduction and diesel oxidation catalysts on to existing equipment which reduce nitrogen oxides to benign gases naturally found in air.[4] Their 2006 retrofit of the Alice Austen cut emissions by 16.5 tons of nitrogen oxides per year and reduced particulate matter by 25 percent.[5]

1 NYC Department of Transportation Website, "Staten Island Ferry," (http://www.nyc.gov/html/dot/html/ferrybus/statfery.shtml): Accessed 12/17/07

2 In particular, Bronx Community Boards 2,4 and 7, Brooklyn Community Boards 1 and 10, Manhattan Community Board 1 and Staten Island Community Board 2 all expressed interest in ferry service to ease congestion.

3 Clean Air Task Force Website, "Diesel Engines: Emissions and Human Exposure," (www.catf.us); Accessed 12/18/07

4 US EPA, "Press Release: Cleaner Emissions from Staten Island Ferry just the Beginning -- Northeast Diesel Collaborative Expands Efforts," 31 January, 2006

5 ibid.

Hybrid ferry technology can also reduce pollution by substantial quantities. Some hybrid models, such as the Foss hybrid tugboat which is being introduced in the Los Angeles and Long Beach Ports, have been proven to reduce particulate and nitrogen oxide emissions by 44% without a reduction in power.[6] In addition, most hybrid models show significant reductions in noise pollution, something that retrofits cannot do. Lastly, the use of hybrid technologies reduces fuel consumption. Many hybrid operators report lowered operations costs; especially important in a time of rising world oil prices.

Dolphin Class FOSS tugboats directing a shipping vessel. The FOSS hybrid tugboat will produce a fraction of the air pollution. Image used with permission of Foss Maritime.

6 FOSS Website; "PRESS RELEASE: WORLD'S FIRST TRUE HYBRID TUG TO BE BUILT BY FOSS MARITIME;" (http://www.foss.com/press/Press_Release_030207.html); Accessed 11/09/07 & The Associated Press, "Foss, California ports join to develop hybrid tugboat;" Seattle Post-Intelligencer, 3 March, 2007

Case Study 1: The Solar Sailor (Sydney, Australia; San Francisco, CA)

The original Solar Sailor in Sydney harbor operated by Captain Cook Cruises. The wing panels serve as sails while simultaneously collecting solar energy. Image used with permission of Solar Sailor (www.solarsailor.com).

The Solar Sailor, described by Terry McRae of Hornblower Cruises, as "a Prius on steroids," is an award-winning hybrid vessel from Australia.[7] It is unique, even among hybrid vessels, because it adds wind power to the typical diesel-solar hybrid technology.[8] It has been in use as a passenger ferry in Sydney Australia since the 2000 Olympic Games and will begin operations in San Francisco Harbor (National Parks Service Alcatraz concession) in 2008.[9] It was proposed for New York harbor by Circle Line Downtown in their unsuccessful bid for the Statue of Liberty National Parks concession.[10]

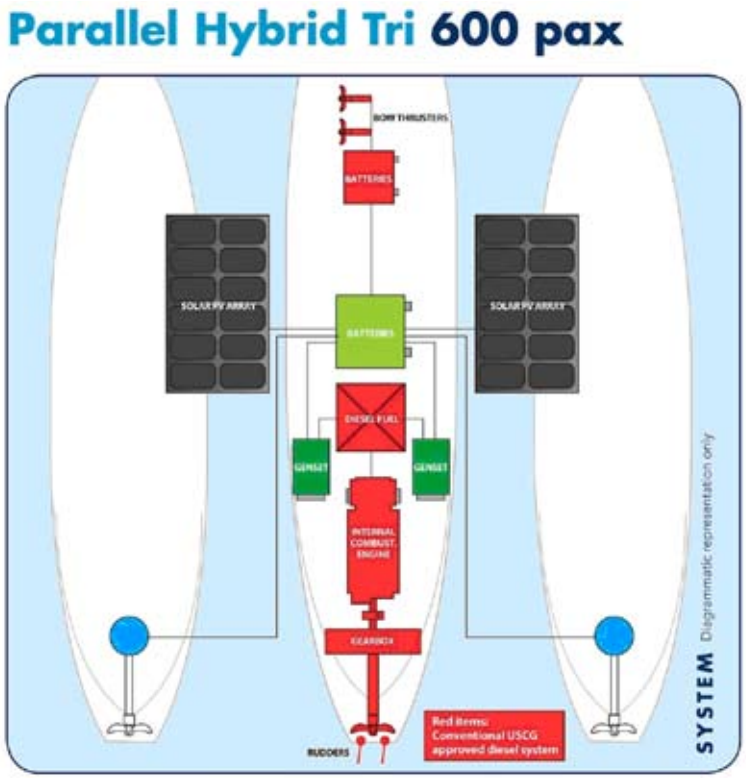
7 Phone Interview with Terry McRae, CEO Hornblower Cruises, 1 June, 2007

8 Since its introduction in Sydney, Solar Sailor has won a number of best technology awards including the 2000 Boating Industry Association of Australia's Best New Product Award, the 2000 International Cargo Handling Co-Ordination Association Award for Cargo Handling, and the 2001 Australian Design of the Year Award in Engineering. Solar Sailor has been awarded two grants from the US Military (2005 and 2007) to develop unmanned ocean vehicles. (Dane, Robert; "Technology Solutions: Safe, Efficient Hybrid Marine Power." Solar Sailor Brochure)

9 Phone Interview with Terry McRae, CEO Hornblower Cruises, 1 June 2007

10 In June 2007, the Parks Service selected Hornblower Cruises as the winner of this concession. There has been no indication as to whether Hornblower will consider Solar Sailor

Solar Sailor vessels are hybrid catamarans equipped with rigid movable "wings" which operate as sails or can be folded flat in extreme wind (40 knots +) conditions. The top surface of these wings are covered with solar paneling, as are other surfaces of the vessel. As hybrid vessels, Solar Sailors can generate power from their internal combustion engines (diesel/liquefied petroleum gas LPG) or from electric batteries charged by the solar arrays and the internal combustion engine. The two power sources to work independently, which slightly reduces the energy efficiency but increases the power and speed of the vessels.[11]



Internal combustion and electric engines give the Solar Sailor a greater degree of flexibility and efficiency. Image used with permission of Solar Sailor (www.solarsailor.com)

On-board control panels allow the ships' captains to choose which power source makes sense at different speeds—solar/electric for low speeds or idling, internal combustion engine for higher speeds or cruising. Such a design is ideal for vessels that must start and stop frequently, like commercial or commuter ferries.[12] In addition, the ability to switch between power sources as needs and conditions change means a dramatic reduction in fuel use. Solar Sailor's Sydney operator, Captain Cook Cruises, reports up to 50% fuel savings on its routes.[13] Since the vessels can be entirely powered by their solar/electric engines while at the dock, they produce zero idling emissions and substantial reductions in air (NOx, PM, CO2, etc.) and noise pollution. In addition, the vessels are designed with a "Low-Wash" hull design that minimizes impacts on piers and bulkheads.[14]

Unlike other hybrid vessels, Solar Sailor can also reduce fuel use and emissions while in motion or at high speeds, since its wing panels allow it to gain additional speed without expending more fuel. Although this has not been tested outside of Sydney, Hornblower CEO, Terry McRae believes that the 1 ¼ mile Alcatraz route, which typically sees winds of around 25 knots, will be an ideal testing ground.[15]

The Solar Sailor computer systems utilize GPS systems and rely on NASA and National Weather Service data to predict wind direction and the location of the sun allowing the Solar Sailor crew to orient wings and paneling to the best position.[16] In addition, the GPS system allows for certain automatic safety measures, like lowering the wings if the vessel is traveling above a certain speed within 50 yards of a wharf or under bridges.[17]

technology for this route as well as the route for Alcatraz.

11 The slight efficiency loss is not unique to Solar Sailor. Electric motors in general are more efficient than diesel engines because they can use optimally size propellers which internal combustion engines cannot.

12 Dane, Robert; "Technology Solutions: Safe, Efficient Hybrid Marine Power." Solar Sailor brochure provided by Robert Dane

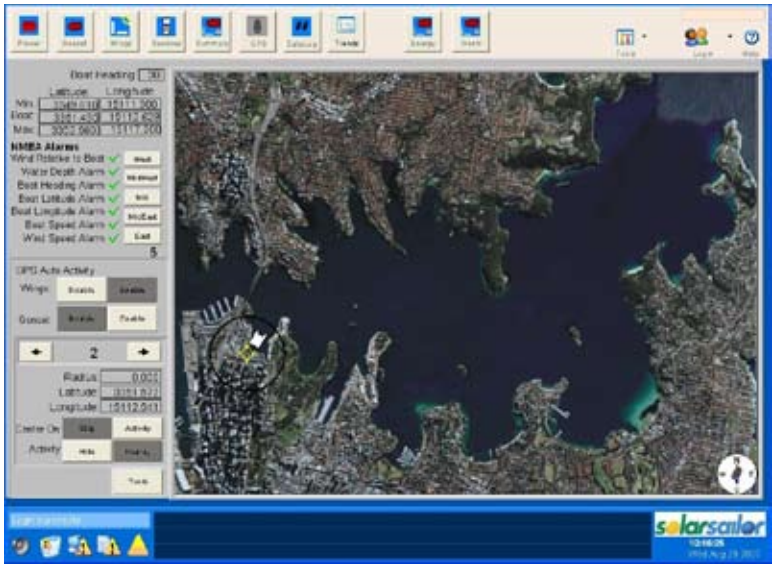
13 Email Correspondence with Anthony Haworth, Managing Director, Captain Cook Cruises 17 May, 2007

14 Solar Sailor, "Hybrid Marine Power Brochure," Courtesy of Robert Dane, www.solarsailor.com

15 Phone Interview with Terry McRae, CEO Hornblower Cruises, 1 June, 2007

16 Solar Sailor Website, (www.solarsailor.com); Accessed 12/18/07

17 Interview with Robert Dane, Solar Sailor, and JB Meyer, NY CircleLine Downtown, 30 May, 2007



Solar Sailor's on-board computer and GPS systems monitor a variety of important aspects of the ship's voyage and route including wind speed and direction, water depth, vessel direction and heading and location. Image permission: Solar Sailor (www.solarsailor.com).

The addition of the solar array, batteries and electric engine means that Solar Sailor vessels cost more than conventional ferries. MacRae estimates that that the Solar Sailors for Alcatraz will cost about $15,000 per seat if they chose to build 600 passenger ships and more, $20,000 per seat, if they build a smaller 300 passenger ship. Hornblower Cruises has budgeted $5 million for the development of the two Solar Sailor vessels.[18]

Reductions in operating costs may offset increased capital costs. JB Meyer, the CEO of New York City's Circle Line Downtown estimated if Solar Sailors were to run on their Statue of Liberty route, Circle Line Downtown would reduce its fuel consumption by up to 30% each year and would recoup the increased vessel cost within 12 years.[19]

18 Phone Interview with Terry McRae, CEO Hornblower Cruises, 6/01/07 & Witherell, Amanda. "Casting Off; New Alcatraz Ferry Service Leaves Unions, Environmentalists, and City Officials Fuming on the Dock;" SF Bay Guardian Online; (http://www.sfbayguardian.com/printable_entry.php?entry_id=1707); Accessed 11/09/07

19 Interview with Robert Dane, CEO Solar Sailor, and JB Meyer, CEO Circle Line Downtown, 30 May, 2007

Examples and Opportunities in New York City:

Expanding ferry service in the New York region is an important 2030 PlaNYC goal and hybrid ferries represent a way to further facilitate environmentally friendly maritime transportation and reduce fuel cost and consumption for ferry operators

In addition to technological advances like catalytic converters that can reduce the amount of air pollution produced by diesel marine engines, this report recommends the further investigation of hybrid power options. Hybrid technologies present options for new private ferry fleets (such as NY Waterways or WaterTaxi) which can be spurred by regulations or tax incentives, and for city-operated ferries, such as future Staten Island Ferry purchases.

BIKE-SHARE PROGRAMS

Bike-share programs are a way to extend the reach of existing transit modes like rail, subway or bus and increase bicycle mode split in cities. Bike-share programs exist in many European cities—including London, Paris, Barcelona, Rome, Berlin, and Oslo—and bike-share programs are in the works in the United States as well. SmartBike, the first US program opened in August 2008. A list of bike-share programs worldwide can be found in Appendix B.

Background:

Barcelona's Bicing bicycle-share program, operated by Clear Channel Adshel. Image used with permission of Clear Channel Adshel.

Bike-share programs are technologically enhanced versions of free public bicycles. Program operators place bicycles at "kiosks" throughout a coverage area. Program members can pick up bicycle by swiping their membership card at any kiosk and return the bicycle to any other kiosk. Bike-share programs tend to increase both commuter and recreational/errand bicycling when spread over a large area with many kiosks at which users can pick-up or return bicycles. The high kiosk density allows the programs to serve the needs of commuters or people running errands who can pick up a bicycle at their front door, ride to the Metro, store or work, and leave the bicycle at a kiosk there without further worry. Bike-share programs are usually priced in 1/2 hour increments to encourage use and rapid bicycle turnover.

Bike-share programs first appeared in the mid-1960's as fleets of free, brightly painted bicycles placed around a city for public use. However, theft and vandalism of the bicycles quickly ended most of these programs. Subsequent programs attempted to address these issues by using uniquely designed bicycles with parts that could not be interchanged with traditional bicycles, by requiring a coin deposit to retrieve a bicycle, and by creating designated terminals for pick-up and drop-off within the bike-share area.[20] However, theft remained a challenge because there was no way to track the bicycles once they left the bike terminal.

The newest bike-share programs, often called 3rd generation programs, solve the problem of bicycle theft and damage through membership and use fees and automated, wireless technologies. Membership data links customer identification to each bike hire. Customer credit cards are charged for lost or damaged bicycles.[21] Theft in 3rd generation programs is limited since bike-share operators have the ability to fine customers for unreturned or damaged bikes in their name.[22] Like the earlier programs, 3rd generation bikes still utilize distinct bike-sharing designs and colors which make them easily identifiable to potential users. Dismantling 3rd generation bike-share bicycles requires special tools and the parts cannot be interchanged with traditional bicycles making their resale value negligible.

High population density, a dense urban environment and the existence of cycling infrastructure such as bike lanes are some of the most important pre-requisites for successful bike-share programs. New York City's average density (excluding Staten

20 DeMaio, Paul and Jonathan Gifford, "Will Smart Bikes Succeed as Public Transportation in the United States?" Journal of Public Transportation, Vol.7, No.2, 2004, p.3

21 Remarks by Josh Squire, JCDecaux Bicycle System Manager, Keynote Speaker for the Forum on Urban Design and Storefront for Architecture Charette, " The New York Bike-Share Project." 10 July, 2007

22 According to Richard Grass of ClearChannel Adshel, bike theft is common the first year or two a bike-share program is in operation, however, theft diminishes as the novelty of the program wears off. To date, about 300 bicycles have been stolen from Paris's program.

Island) of around 48,000 people per square mile is on par with other cities with sucessful programs; Paris, for example, home of the world's largest bike-share program has around 53,000 people/square mile.

New York City's cycling infrastructure has improved over the past 10 years. With the charge from PlaNYC 2030, New York City will benefit from 1,800 additional miles of bike lanes spanning the five boroughs by 2030. 200 miles are scheduled for completion by the end of 2009.[23] Bicycle lane enforcement is still a challenge as many lanes are used (illegally) as additional parking or driving lanes. NYCDOT is introducing newly designed protected bike lanes. The pilot protected lane, on Ninth Avenue in Manhattan has been highly sucessful and NYCDOT plans to add 15 more miles of protected lanes by 2009.[24]

The City is also promoting bicycling as an intermodal option, encouraging people to bicycle to subway or bus. In July 2007, NYC DOT replaced vehicle parking spots near a Brooklyn subway station to widen the sidewalk for bike racks.

International attention to bike-share programs has not gone unnoticed in the US. Washington DC's SmartBike program opened in August 2008. Chicago and San Francisco have recently sent out requests for proposal (RFPs).[25] Cities such as Boston, Portland, OR, Phoenix, Albuquerque and Philadephia have also begun preliminary feasibility studies. In August 2008, NYCDOT announced a "Request for Expressions of Interest (RFEI)" for a New York bike-share program.

23 NYC Department of Transportation, "Sustainable Streets 2008 and Beyond; NYCDOT Strategic Plan," April 2008

24 ibid.

25 Remarks by Josh Squire, JCDecaux Bicycle System Manager, Keynote Speaker for the Forum on Urban Design and Storefront for Architecture Charette, " The New York Bike-Share Project." 10 July, 2007

Case Study 2: Bicing & Velib' (Barcelona, Spain; Paris, France)

Image by Joseph Simpson/Movement Design Bureau, used under the terms of cc-by-sa-2.0 (http://creativecommons.org/licenses/by-sa/2.0/). Available at http://movementbureau.blogs.com/projects/2007/12/velib---a-photo.html.

Bicing, in Barcelona, and Velib', in Paris, are two of the world's largest bike-share programs to date. Both programs opened in 2007, Bicing in March with 1,500 bicycles and Velib' in July with 10,000 bicycles. Both programs have also expanded substantially since their inception. Bicing, a ClearChannel Adshel program, now boasts 6,000 bicycles and over 400 kiosks. Velib', a JCDecaux program, now has 20,600 bicycles and over 1,400 kiosks. Plans to expand Velib' to 28,500 bicycles to include the Parisian suburbs have recently been announced.[26] Both programs were designed to complement existing public transportation options.

Data from Bicing, Velib' and the other European bike-share programs indicate that bike-share programs can increase bicycle ridership in a city. In Lyon, France, bicycle riding increased by 44% within a year as a result of introducing a bike-share program.[27] 96% of those first year riders had never before bicycled in the Lyon city center.[28] Current data from Paris shows that the city has seen a 70% increase in bicycle use and a 5% reduction in car use and congestion since Velib' was introduced.[29]

Commuters are major users of bike-share programs. In Paris, respondents to a JCDecaux survey indicated that 74% of bicycle trips were made for work purposes.[30] Velib' ridership close to doubled during the transit strike in the winter of 2007-8. Data from ClearChannel Adshel's programs indicates similar results. 60% of ClearChannel Adshel's bike-share subscribers use the bikes in their commute.[31] 45% of Clear Channel's membership bases uses a public-use bike more than five times per week.[32] In general, bike-share bicycles are used 10-15 times per day.[33]

The popularity of bike-share programs can be seen in their membership sales. In Barcelona, Bicing sold almost 100,000 annual memberships in the first six months alone.[34] In Paris,

26 Pirolli, Bryan, "Velib' Hits the Paris Burbs;" Conde Nast Traveler, (http://www.concierge.com/cntraveler/blogs/80days/2008/08/velib-hits-the.html); Accessed 9/2/08
27 NICHES, "New Seamless Mobility Services: Public Bicycles;" European Commission, DG Research, 6th Framework Program, p.2 (www.rupprecht-consult.de/download/niches_public_bikes.pdf); Accessed 06/19/07
28 Holtzman, David, "Bike-Sharing," Planning, May 2008, p.21
29 Bremner, Charles & Marie Tourres, "A year on, the cycle experiment has hit some bumps;" The London Times, 8 July, 2008
30 Velib' Website, "Press Release: Appendices Opinion Poll;" (http://www.velib.paris.fr/espace_presse); Accessed 3/24/08
31 Clear Channel Outdoor Website, "SmartBike™;" (http://www.smartbike.com/); Accessed 3/24/08
32 Clear Channel Outdoor Website, "SmartBike™;" (http://www.smartbike.com/); Accessed 3/24/08
33 Velib' Website, "Press Release: Velib' is Changing the City!" (http://www.velib.paris.fr/espace_presse); Accessed 3/24/08
34 Scholtus, Petz; "The TreeHugger Interview with Mayra Nieto, Barcelona Municipal Service: Bicing, Barcelona's Bike-Sharing System;" (http://www.treehugger.com/files/2008/01/

Velib' had 100,000 annual membership subscribers within the first eight weeks.[35] Twelve weeks after their introduction, Velib' public-use bicycles had been used over seven million times.[36] There have been 30 million Velib' trips in the first year; approximately 120,000 trips per day.[37]

Velib' in Paris has been particularly adept at using its membership and use fees structure to encourage ridership. The Velib' fee structure incentivizes many short trips instead of a few long trips by requiring users to pay increasingly more as any given trip continues past one hour. For example, the first half hour of Velib' usage—enough time to bicycle to a local store or train station—is free; a user would pay €1 for the second 1/2 hour, €2 for the third 1/2 hour and so on which encourages users to return that particular bike to a kiosk for use by other Velib' members. Bicing, in contrast, offers the first 30 minutes for free but charges a flat rate (€.30) for each additional half hour period up to 2 hours. Also unlike Bicing and a number of other programs, Velib' offers daily (€ 1) and weekly passes (€ 5), in addition to its annual pass (€ 29), which allow prospective members to test the system as well as offering options for visitors and tourists. In the first six-months alone, Velib' sold 2.5 million one day passes.[38]

Bike-shares can vary from a few hundred bicycles to several thousand, depending on the size of the city and the purpose of the program. Velib', in Paris, is unique in its size and coverage of the city. Kiosks are placed every few blocks and are place on the sidewalk, in the place of car parking spots, along the edges of public parks and under elevated train tracks. The number of bicycles available and the degree of kiosk coverage allows the program to substantially impact and interact with existing transit services in the city. JCDecaux's other programs are also located in larger French cities like Marseilles (1.6 million people) and Lyon (1.7 million people), and have between 3,000 and 10,000 bicycles, but do not (yet) cover the entire city.

A map of Paris showing the proposed location of every Velib' bicycle-share kiosk. In order to maximize the impact of bicycle-sharing, the city of Paris worked with JCDecaux to place kiosks everywhere. Image used with permission of JCDecaux.

In contrast, ClearChannel Adshel's programs, like Bicing, tend to cover less of the city and provide fewer bicycles (1,000 to 1,500). While geared toward commuters, because they do not offer short-term memberships, their kiosk locations (only in the center city) make them better suited for trips during the work day than a full-scale commuter option. Nibici, a CEMUSA program in Pamplona, Spain, focuses on recreation and thus only provides 350 bicycles at 20 stations across the city.[39] The Deutsche Bahn's Call-A-Bike program avoids the kiosk model entirely by allowing users to lock bicycles to any stationary object near a train station or prominent intersection in the city center. However, such a

the_th_intervie_28.php); Accessed 9/2/08

35 Cardwell, Diane, "In Paris, Bloomberg Eyes Bike Program for Home;" The New York Times, 30 September 2007

36 Rayman, Eric, "Finding Liberté On TwoWheels;" The New York Times, 14 October 2007

37 Erlanger, Steven, "A Fashion Catches On in Paris: Cheap Bicycle Rentals," The New York Times, 13 July 2008

38 DeMaio, Paul; "The Bike-Sharing Blog;" (http://bike-sharing.blogspot.com/); Accessed 6/25/08

39 Remarks by Carlos Pujol, CEMUSA Corporate Development Director, Keynote Speaker for the Forum on Urban Design and Storefront for Architecture Charette, " The New York Bike-Share Project." 11 July, 2007

model makes it difficult for potential users to predict where they might find a bicycle and limits the range which users can take them.[40]

In addition to kiosk location , distribution of bicycles at the kiosks is one of the major operational challenges that bike-share operators like CEMUSA, ClearChannel Adshel and JCDecaux have faced in their European programs. These operators use extensive, on-going monitoring and redistribution vehicles to help manage the location of their bicycles over the course of the day. Bicycles are equipped with radio frequency identification, (RFID) technology which enables program operators to track the location of its fleet and monitor the status of each bicycle.[41] If a bicycle is malfunctioning, the bicycle computer alerts the main computer monitoring system which dispatches a redistribution vehicle to fix the problem. All companies use redistribution vehicles to move bicycles around the city as needed. Velib' employs 400 people to monitor its fleet of 20,600 bicycles.

Bike-sharing programs are self-service. As a result, they cannot enforce the wearing of bike helmets. In addition, because there is no way to effectively monitor structural wear-and-tear on a given helmet, bike-share operators are unwilling to rent helmets to users for liability reasons. However, operators can encourage helmet usage through their own operations. JCDeceaux, has a patent pending on a "smart" helmet which doubles as a membership card.[42] The city of Paris has also introduced a number of safety campaigns to encourage helment use and good bicycling behavior.

40 Call-A-Bike website, English Version (http://www.callabike-interaktiv.de/kundenbuchung/process.php?proc=english&f=500); Accessed 11/14/07

41 Clear Channel Outdoor Website, "SmartBike™;" (http://www.smartbike.com/); Accessed 3/24/08

42 Phone Interview with Josh Squire, Bicycle System Manager JCDecaux, 10 September, 2007

In order to ensure that there are enough bicycles at high-demand locations, most third generation bicycle-share programs have developed a system to redistribute bicycles as needed. Image used with permission of Clear Channel Adshel.

Financing Bike-Shares:

While the earlier bike-sharing programs were predominantly started and operated by local governments or non-profits, most 3rd generation bike-share programs have been developed as public-private partnerships by advertising and street furniture companies (CEMUSA, ClearChannel Adshel and JCDecaux) seeking advertising contracts with municipalities. Velib', for example, is tied into the billboard franchise contract that JCDecaux holds with the city of Paris. In exchange for rights to 1,628 advertising billboards and other street furniture, JCDecaux maintains and operates Velib' and carried the full cost of the initial start-up capital ($142M).[43] JCDecaux expects to earn $94M annually in advertising revenues.[44] In contrast, Bicing, while run

43 Nadal, Luc; "Bike Sharing Sweeps Paris Off Its Feet;" Sustainable Transport, Institute for Transportation and Development Policy; Fall 2007, Number 19 & Erlanger, Steven, "A Fashion Catches On in Paris: Cheap Bicycle Rentals," The New York Times, 13 July 2008

44 Erlanger, Steven, "A Fashion Catches On in Paris: Cheap Bicycle Rentals," The New York

by a street furniture advertising company, ClearChannel Adshel, is paid for directly by the city of Barcelona, as Barcelona's street furniture is already under contract. Bicing is financed with Barcelona's Green Area roadside parking program surplus and subscription revenue.[45]

As different types of advertising space command different prices, cities and companies must negotiate to ascertain how many bicycles will be provided and what types of advertising space will be used. In franchise programs, advertisting revenues are usually split. For example, the Washington DC SmartBike, comes as an extension of Washington DC's bus-shelter agreement and the city earns 35% of advertising revenues.[46]

In Oslo, Norway, Clear Channel Adshel collects revenue from advertising billboards to pay for their bike share program. Image used with permission of Clear Channel Adshel.

Times, 13 July 2008

45 Scholtus, Petz; "The TreeHugger Interview with Mayra Nieto, Barcelona Municipal Service: Bicing, Barcelona's Bike-Sharing System;" (http://www.treehugger.com/files/2008/01/the_th_intervie_28.php); Accessed 9/2/08

46 Phone interview with Richard Grasso and Martina Schmidt, ClearChannel Adshel, 30 April 2008

A preliminary analysis conducted by Clear Channel Adshel suggests that, using the public-private partnership model, New York City could introduce 500 bikes and locate 36 stations with an initial capital investment of $50,000 per station. The initial investment includes the following elements: bicycles, spare bicycles, docking stations, hardware and software, service trucks and installation of stations. A 500 bike and 36 station program requires $27,000 per kiosk per year for operational expenses which cover the program manager, service personnel, administrative personnel, distribution vehicle maintenance, electricity, wireless connectivity, website platform, smart cards, bike theft, insurance and warehouse costs.[47]

Modifications to kiosk design could reduce costs. Montreal's recently announced bike-share program, Bixi, is anticipated to have lower capital costs because their kiosks are solar powered and mounted on metal plates which are bolted into the ground.[48] Bicing and Velib' kiosks in contrast, require excavation and electrical hook-ups for installation.

Examples and Opportunities in New York City:

Introducing a bike-share programs in New York City is in keeping with the city's 2030 PlaNYC vision to increase bicycle use in the city and provide New Yorkers with more options to access existing transit. In addition, because bike-share programs are designed for short trips they could help to reduce some pressure on overcrowded subway lines.

Proposals for a New York City bike-share program should first consider what benefits the city hopes to realize. Small programs and pilots can generate attention quickly but often fail to produce increases in bicycling or any associated multi-modal transportation gains. Larger programs, although initally more costly, can, as Paris is demonstrating, create substantial shifts in mode-split and may reduce congestion. In general, a bike-share

47 Email Correspondence with Richard Grasso, Senior Vice-President, Business Development, Clear Channel Adshel, Inc. 1 October, 2007

48 Phone Interview with Alain Ayott, Executive Vice-President, Montreal Parking Authority; 3 & 11 July, 2008

program will not provide significant benefits without covering a large portion of the city.

New York neighborhoods with high residential and worker population density are strong candidates for a bike-share program. These areas include: Manhattan and western Brooklyn including Coney Island, the Bronx south of Van Cortlandt Park and west of the Bronx River, and Queens west of Flushing Meadon Park, and Flushing and Kew Gardens. Areas around transit hubs should also be considered. In addition, major destinations, like Yankee and Shea Stadiums, the Metropolitan Museum of Art and Coney Island, should also be included in the program coverage, especially if short-term (tourist) passes are sold.

New York City's geography and existing patterns of bicycle use and placement of bicycle infrastructure are also factors in developing a successful bike-share program. Boroughs like Manhattan and Brooklyn, and parts of other boroughs like the southwestern Bronx and western Queens may lend themselves better to bicycle-sharing because they are denser, have considerable existing bicycle lanes and are less car-dependent already.

Other issues that would need to be addressed include identifying locations for kiosks, increasing bicyclist safety, and further analyzing funding and procurement options. A phased roll-out may be useful to build program momentum. Phasing could begin in Manhattan, where population and worker densities are highest and the bike-lane infrastructure is the most robust.

PASSENGER, FREIGHT AND AERIAL STREETCARS:

Throughout North America and Europe, streetcars are making a comeback as a viable mode of urban transportation. In contrast to new roads for cars and buses or tunnels for subways and trains, streetcars typically require less infrastructure investment and provide reliable, fast on-street service. Most run off electricity and so do not directly contribute to air pollution. Aerial streetcars are placed on tracks above existing right-of-ways, thus increasing the capacity of existing transportation corridors without using precious space on the ground. In addition, cities that have invested in streetcars report significant economic development increases related to streetcar use. This report surveys the following three modern streetcar applications:

- Passenger streetcars (Portland, OR)
- Freight streetcars (Dresden, Germany)
- Aerial streetcars (Wuppertal, Germany and Goa, India)

Background:

As in many cities around the US, streetcars were an integral part of New York City's transportation network until the mid-20th century. Nationally, streetcars reached their peak ridership around 1920, just shy of 14 billion rides per year. After the Great Depression, streetcar ridership rose again to around 10 billion rides per year, but was overshadowed by bus ridership, a new force on the transportation horizon that benefited from increasingly car-oriented post-war local, state and federal transportation funding policies.[49] The last streetcar in New York City ended service in 1956.

Modern streetcars differ from historical streetcars, in use in San Francisco or rusting in Red Hook for example, in that they are fully enclosed train systems, built to current safety, noise and Americans with Disabilities Act (ADA) specifications. In general, modern streetcars differ from other forms of urban rail transit, like subways or light rail, in that they are smaller, lighter and

49 Slater, Cliff, "General Motors and the Demise of Streetcars," Transportation Quarterly, Vo. 51, No. 3, Summer 1997

more maneuverable in city traffic. Their relatively low weight means that most streets can handle the weight of a streetcar route without additional infrastructure work thus reducing costs and construction time.[50] Streetcars run on electricity, supplied by the local power grid. A pole attached to the streetcar touches an overhead catenary wire which provides up to 600 volts DC. Modern catenary pole and wire designs are aesthetically pleasing and unobtrusive.[51]

A number of American cities, such as Portland, Oregon, Omaha, Nebraska and Atlanta, Georgia, have built or proposed modern streetcars to compliment their existing transportation networks. Paris, France has recently opened its new T1, T2 and T3 tramway streetcar system which serves Paris' inner suburbs.[52]

50 Omaha Streetcar, "Streetcar FAQ;" Omaha Streetcar (http://www.omahastreetcar.com/education/index.html); Accessed 11/07/07

51 ibid.

52 RATP Website, (www.ratp.fr); Accessed 12/18/07

Case Study 3: Passenger Streetcars (Portland, OR)

The Portland Streetcar is easily integrated into existing traffic patterns. Image by Chris Phan used under the terms of cc-by-sa-2.0 (http://creativecommons.org/licenses/by-sa/2.0/).

In 2001, the City of Portland became the first US city to re-introduce a new streetcar network to augment its existing public transit systems (bus and MAX light rail). In contrast to the city's existing MAX commuter light rail network, these streetcars are shorter, lighter, narrower and have a higher degree of on-street maneuverability. Unlike the MAX, which brings commuters in from Portland' suburbs, the Streetcar is designed to offer an alternative to driving for people already in the city. The Portland Streetcar is owned and operated by the city of Portland.

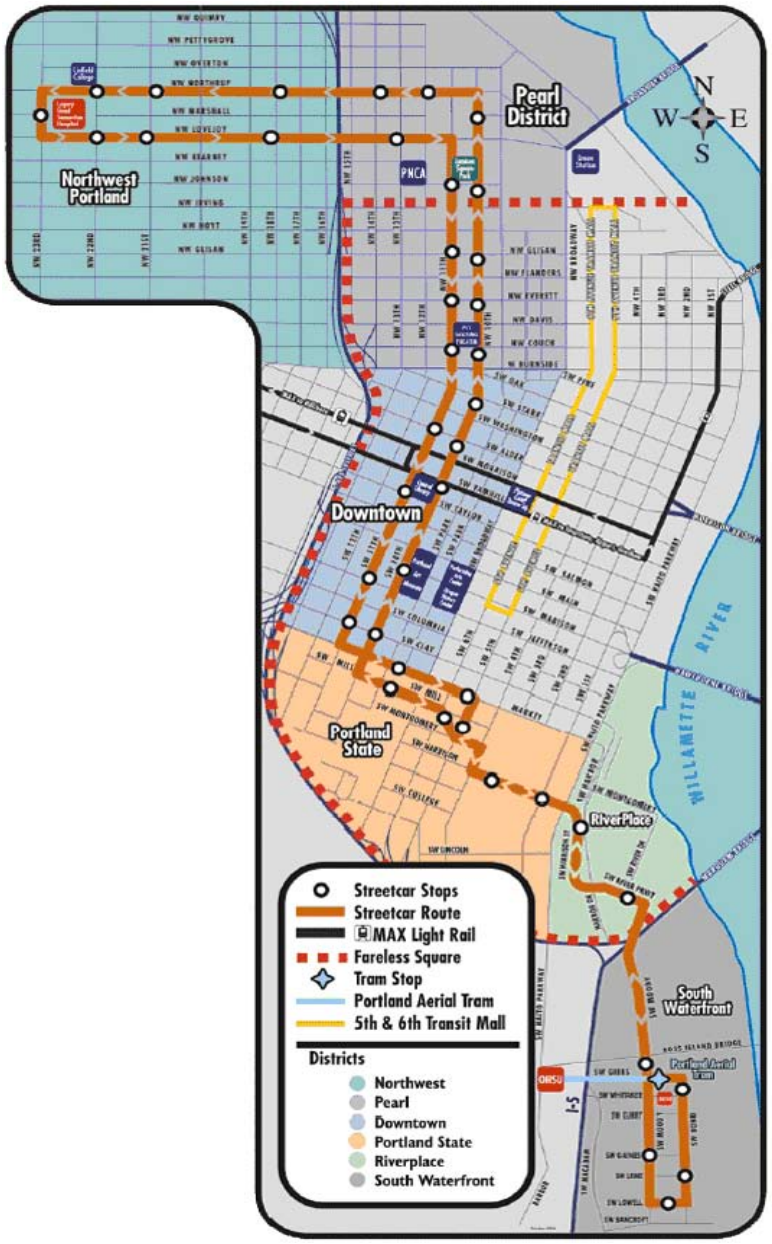
The Portland Streetcar runs on a 7.2 mile loop that connects Portland's NW and SW (downtown) neighborhoods.[53] The

53 Portland Streetcar Website, "Streetcar History," (http://www.portlandstreetcar.org/history.php); Accessed 11/27/2007

streetcars stop roughly every 3-4 blocks and have stations at a variety of major Portland institutions such as the Good Samaritan Hospital, Pacific Northwest College of Art (PNCA), the Portland Art Museum and Portland State University (PSU). According to Portland Streetcar Project Manager, Vicky Diede, recent development along the streetcar line has made the streetcar an easy choice for many daily activities: going to work or school, doctors' appointments, grocery shopping, visiting museums, dropping children off at daycare or getting morning coffee.[54] The streetcar connects with the city's existing commuter MAX light rail system (which connects Portland's northern, western and eastern suburbs and the Portland International Airport), the Portland Bus Mall and the new aerial Tram (which connects downtown Portland to major hospitals and job centers, the VA Hospital and Oregon Health and Sciences University OHSU).

For most of its route, the Portland Streetcar shares the right-hand lane with cars, next to the parking lane. At station stops, the parking lane is replaced by a curb bulb out. Like buses, the streetcars only stop when signaled by riders or when there are people waiting at the streetcar stop. To ensure traffic flow, the streetcars are outfitted with a wireless Opticom System which allows them to communicate with traffic signals in order to extend green lights or clear intersections for wide turns.[55] This system also allows the Portland Streetcar to offer real-time arrival information to passengers waiting at streetcar stops.

Storage yards for the streetcars are located underneath the I-405 freeway on land leased from the Oregon State DOT by the city of Portland. The current facility uses approximately 100,000sf and it will be expanded when additional streetcar lines are added.[56]



The Streetcar route connects riders to a variety of cultural institutions, job centers and other transit modes including Portland Metro's MAX lightrail and the new aerial Tram. Image used with permission of the City of Portland's Office of Transportation.

54 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 9 July, 2007
55 ibid., 8 May, 2007
56 ibid., 9 July, 2007

Ridership on the Portland Streetcar has increased steadily. Planners initially estimated that ridership for the streetcars would be about 3,000 riders/day. When the streetcar opened in 2001, weekday ridership was about 5,000 passengers per day; as of spring 2007, over 10,000 passengers used the streetcar each day. On the weekends, the streetcar is also widely used. In spring 2007, Saturday ridership had reached 9,300 and Sunday ridership stood around 4,700.[57]

Ridership data also indicates some positive spillover effects from the streetcar. Bus ridership in the areas served by the streetcar declined initially after the streetcar began operations but has since rebounded and overall public transit use in the area has increased.[58] Building on the success of the original streetcar route, the City of Portland Office of Transportation is exploring two additional streetcar loops one serving Portland's east side (the Portland Streetcar Loop) and the other serving the nearby suburb of Lake Oswego.[59]

Streetcar systems can be built faster than light rail, commuter rail or subway. In Portland, streetcar track was laid at a rate of approximately one block per week.[60] Since streetcars are lighter than light-rail, most streets can handle the weight of a streetcar route without additional infrastructure work thus reducing construction time.[61]

Placement of streetcar tracks in relation to subterranean infrastructure like water and power lines remains an issue, however, and would be particularly challenging in the more intensely developed parts of New York. In Portland, streetcar planners attempted to avoid overlaps between underground utilities and the streetcar tracks and required private utilities to relocate their lines when they conflicted directly with the streetcar tracks. Shallow water lines located within 5 feet of the streetcar track were moved; deeper sewer lines, unless they ran directly below the tracks, were left alone with offset manhole covers for access. Since the concrete trackbed is structural, places where shallower lines cross under the tracks perpendicularly can be accommodated; the track slab can support up to 10 feet of excavation and still carry streetcars.[62]

In Portland, construction of the first 2.4 miles of track began in September 1999 and service commenced in the summer of 2001. Construction on the subsequent portions of the streetcar track was implemented in three subsequent phases with each extension taking approximately one year from groundbreaking to full service.[63] Streetcars can sustain an 8% grade, or as much as 9% over short distances, so they are easily introduced into most street contexts with minimal street alterations.[64]

Diede describes construction of the streetcar track as follows:

> [The track] is 8 feet wide and 14-16" deep and it is a concrete, structural trackslab. Basically, those dimensions are sawcut out of the street, rock may or may not be needed depending on the condition of the roadbed, rebar is laid, the tracks and rubber boot (for cathodic protection) are installed and then the final pavement is poured. We constructed the trackslab in three block sections and completed the section in three weeks (for straight track sections -- curved sections took longer).[65]

Funding for the Portland Streetcar came almost entirely from state and local, both public and private, funding sources with

57 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 27 November 2007
58 ibid.,9 July 2007
59 Portland Streetcar Website (http://www.portlandstreetcar.org/lakeoswego.php): Accessed 11/09/07
60 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 8 May 2007
61 Omaha Streetcar, "Streetcar FAQ;" Omaha Streetcar (http://www.omahastreetcar.com/education/index.html) Accessed 11/07/07
62 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 5 February, 2008
63 Portland Streetcar Website (http://www.portlandstreetcar.org/history.php): Accessed 11/09/07
64 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 5 February, 2008
65 ibid., 8 May, 2007

limited federal money.[66] The construction costs for the first phase totaled $56.9 million and included the purchase of 7 streetcars. Track construction for the first phase cost $13 million per track mile.[67] Of the $88.7 million total construction cost (Good Samaritan Hospital to SW Gibbs), close to 1/3 of the money was raised through city bonds backed by $.20/hour parking rate increase in city garages and almost 20% came from a one-time assessment on property owners within a Local Improvement District.[68]

The original Portland Streetcars were manufactured by the Czech-based Skoda-Inekon. The city saved money by purchasing streetcars that were a standard Skoda product modified to meet US safety standards rather than designing them from scratch. The cars are four-axle, double-ended, cars with a low-floor that is easily wheelchair accessible from the curb via a metal plate. The initial fleet cost a little under $2M per car. Due to the weak US dollar, the most recent cars cost about $2.56 million per car.[69]

Recently, US Representative Peter DeFazio (D-OR) secured a special authorization of $4 million to foster the domestic production of a streetcar vehicle similar to the Portland Streetcar.[70] This new streetcar prototype will be built in the United States by a U.S.-owned corporation and will be fully compatible with the existing tracks and fleet.[71] The 2007 operating budget for the streetcars is $4.2 million, only $80,000 of which is covered by fares.

66 In 1992 the City of Portland received a $900,000 federal HUD grant which it matched with local funds.

67 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 8 May, 2007

68 Portland Streetcar Website, "History," (http://www.portlandstreetcar.org/history.php): Accessed 11/09/07 & Email Conversation with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, 27 November 2007

69 Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, (5/8/07)

70 City of Portland Office of Transportation, "Press Release: Oregon Company to Be Awarded Federal Contract for First US-Made Modern Streetcar;" City of Portland Office of Transportation; 26 January, 2007

71 Skochova, Iva, "Portland's streetcar named Škoda;" The Prague Post, 21 February 2007 & Email Correspondence with Vicky Diede, Portland Streetcar Project Manager, City of Portland Office of Transportation, (11/27/2007)

Economic Development Impacts:

Development in Portland indicates that the streetcar may be a factor in the growth of Portland's downtown; catalyzing private investment. Portland has seen a dramatic increase in investment in the areas served by the streetcar. Since 1997, over $2.28 billion has been privately invested within two blocks of the streetcar's route. This represents 7,248 new housing units and 4.6 million square feet of office, institutional, retail or hotel space.[72]

The impact of the streetcar on development patterns can also be seen through a floor-area-ratio (FAR) analysis. Prior to the development of the streetcar, the typical development in

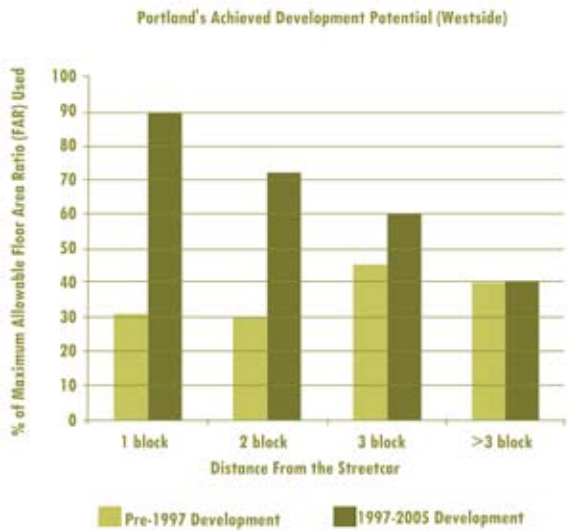
The Pearl District (NW Portland) before the construction of the Portland Streetcar. Image used with permission of the City of Portland's Office of Transportation.

Portland's central business district (CBD) was built to less than half the allowable density.[73] On average, development within

72 Presentation by Richard Brandman, Deputy Planning Director, Portland Metro; "Portland Streetcar Development Impacts: Reconnecting America," December 2006, slide 8

73 Presentation by Richard Brandman, Deputy Planning Director, Portland Metro; "Portland Streetcar Development Impacts: Reconnecting America," December 2006, slide 8, p.3

one block of the streetcar was built at 30% of allowable FAR. In contrast, since streetcar service began, buildings within a block of the streetcar route have been built on average to 90% of allowable FAR, a 300% increase over pre-streetcar development.[74] The streetcar is also encouraging development to cluster in downtown Portland. Prior to the the streetcar, the blocks along the streetcar route captured only 19% of the total development in the CBD. As of 2005, 55% of all CBD development took place within a block of the streetcar route.[75]



The Portland Streetcar has changed development in downtown Portland. Data taken from a 2006 presentation by Richard Brandman, Deputy Planning Director, Portland Metro; "Portland Streetcar Development Impacts: Reconnecting America."

Development along the South Waterfront, the most recent addition to the streetcar route, is also booming. In addition to the new construction pictured in the photos, 5 more buildings were announced in April 2006.[76] The area is also served by the new Portland Tram, which transports people up to Oregon Health and Science University and other medical facilities.

74 ibid.

75 ibid.

76 ibid., slide 22 (This report references a December 2006 photo showing four buildings under construction and notes that six buildings are in development. The DCP photo, taken in May 2007 shows five buildings under construction, hence five buildings in development.)

Oregon Health and Science University (OHSU) research facilities and residential development in the formerly industrial Southwest waterfront. The new Portland Aerial Tram is in the foreground. Image source: NYC Dept. City Planning

These economic development impacts are echoed by other street car programs nationwide. Cities like Atlanta, GA, Cleveland, OH, Tampa, FL and Toronto are all looking at streetcars as a way to spur economic development. In Tampa, FL, as in Portland, the streetcar is favored by developers because streetcars "suggest a sense of permanence, unlike bus routes, which can be changed over night."[77] Unlike Portland, Tampa's streetcar system has widely been deemed a failure in transportation terms because of low ridership. Nonetheless, it has brought over $450 million in residential and retail development to the neighborhoods served by the streetcar. Another $450 million is in development and $1.1 billion is in the planning stages.[78] Tampa planners attribute much of this economic growth to the streetcar and anticipate 10,000 new residents within the next decade.

77 Herrick, Thaddeus; "A Streetcar Named Aspire: Lines Aim to Revive Cities;" The Wall Street Journal, 20 June 2007, B1

78 ibid.

Case Study 4: The Cargo Tram (Dresden, Germany)

In Dresden, Germany, streetcar technology is being applied to freight movement in order to reduce air pollution and congestion caused by trucks. Dresden's CarGo Tram, introduced in 2000, is designed to transport parts and materials from Volkswagen's Friedrichstadt logistics center outside Dresden to its new "transparent" factory in the center of Dresden. The factory, a state of the art assembly plant where luxury D1 Phaeton model cars are built in front of a visitors" gallery, is located in central Dresden.[79] The CarGo Tram is operated by Dresdner Verkehrsbetriebe (DVB), the Dresden Transportation Authority.

The CarGo Trams run primarily on Dresden's existing passenger streetcar lines. Each 5-car tram carries 60 tons of material; the equivalent of 3 trailer truck loads.[80] A spur track leads from the original track directly into the factory itself where the trams can be unloaded. Headway on the trams, once the plant is up to full capacity, will be approximately every 40 minutes. Trams are scheduled to run 21 hours a day and carry roughly 2,000tons/day.[81] At this rate, they will replace over 100 trucks per day. Creative reuse of parts and bi-directional trams have led to additional time and cost savings. The CarGo Tram uses recycled wheel chassis (bogies) and other parts from discontinued high-floor streetcars.[82] Each five-car tram costs about $1.8 million dollars. Engines and drivers cabins at each end allow the CarGo Tram to have quick turn-around times after loading or unloading. Since each tram replaces up to three trucks, DVB also saves money by reducing the number of drivers needed to transport the same amount of materials.

79 Wynne, George, "CarGo Tram Provides Freight Service on Dresden's Light Rail Tracks;" American Public Transits Association
80 ibid.
81 ibid.
82 High-floored streetcars are being replaced with low-floor streetcars all across Europe because low-floored streetcars are more convenient for passengers (and also for passengers in wheelchairs) thus reducing passenger loading and unloading times.

The success of Dresden's CarGo Tram has encouraged planners around Europe to see if similar systems can work in other places where there are multiple companies delivering goods to the same location. In Amsterdam, a pilot CityCargo program began in March, 2007. Companies can avoid central city congestion by bringing their material or goods to CityCargo logistics centers on the outskirts of Amsterdam where it is loaded on to trams. CityCargo Trams move the goods throughout the city, bringing them to strategic offloading points where they are loaded onto small electric trucks for the last stages of delivery.[83] One of the incentives for companies using CityCargo is that it allows those companies to deliver their goods to the logistics centers whenever they want instead of forcing them to follow current regulations in Amsterdam which limit delivery times to between 9am and 11am.[84] Each CityCargo tram will carry up to 30 tons and will replace four 7.5 ton trucks.[85]

CityCargo estimates that the 53 tram cars and 600 electric trucks will replace about 1,200 delivery trucks in Amsterdam.[86] This decrease in truck traffic will result in turn in reduced air pollution (CityCargo estimate up to 16% reduction in particulate matter, carbon dioxide and nitrogen oxides) and less noise pollution since trams are quieter than trucks.[87]

83 CityCargo Website (English Version), "FAQs," (http://www.citycargo.nl/faq_eng.htm); Accessed 11/28/2007
84 ibid.
85 ibid.
86 ibid.
87 ibid.

Case Study 5: Schwebebahn, SkyBus & AeroBus (Wuppertal, Germany; Goa Province, India)

Aerial streetcars have been in use in Wuppertal, Germany since 1901, and have recently been proposed for a number of Indian, Chinese and American cities. They are an important addition to street-level streetcar technologies because they conserve valuable space on the ground. They can be placed in narrow ROWs, in or across rivers, or along existing roads without contributing to traffic congestion.

Wuppertal's Schwebebahn is the oldest example of an aerial streetcar in the world. A suspened monorail that hangs 8-12 meters above the ground, it runs on an 8 mile route between Oberbarmen, Sonnborner Straße, and Vohwinkle in Germany.[88] The Schwebebahn carries close to 80,000 people per day, making it Wuppertal's primary public transit system. It travels at speeds of close to 17mph and maintains 3-4 minute headways during weekdays.[89]

The support structure for the Schewebebahn is constructed out of steel bridge components. The track is attached on the underside of the structure. Cars are suspended from wheels that run on the track and are powered by 600 volt motors.[90] Turn-around points are provided at the ends of each line.[91] The Schwebebahn has an excellent safety record. There have been 5 accidents and one fatality in the Schwebebahn's 100 year history.[92]

88 WSW Website (English Version), (http://www.wsw-online.de/common/welcome.htm); Accessed 7/21/07

89 Bergische Universitat Wuppertal Website (English Version), "Wuppertal's Suspension Railway: overview and history;" (http://www.uni-wuppertal.de/wuppertal/schwebebahn/allgemein-en.html); Accessed 11/28/2007

90 WSW Website (English Version), (http://www.wsw-online.de/common/welcome.htm); Accessed 7/21/07

91 Bergische Universitat Wuppertal Website (English Version), "Wuppertal's Suspension Railway: overview and history;" (http://www.uni-wuppertal.de/wuppertal/schwebebahn/allgemein-en.html); Accessed 11/28/2007

92 Wikipedia Website, (http://en.wikipedia.org/wiki/Schwebebahn_Wuppertal); Accessed 11/28/2007

Wuppertal's Schwebebahn, the oldest aerial streetcar in the world, maximizes transportation uses in the right-of-way.

SkyBus and AeroBus are two newer aerial streetcar systems under development or in prototype form. Like the Schwebebahn, the SkyBus is suspended from a fixed overhead track. Unlike the Schwebebahn, which uses steel supports, the SkyBus track is supported by concrete pillars (approximately 1 meter wide) which are placed every 20 meters, similar to the JFK AirTrain in New York.[93] The SkyBus rails are encased in a concrete box, which prevents derailments.[94]

93 Rajaram, B., "SkyBus Metro: Standard Gauge High Speed Railway System," Document dated 31/10/2007, provided by B. Rajaram, AtriLab & Staff, "SKY BUS METRO IS TOTALLY SAFE," Financial Times/The Hindu, February 8, 2005

94 Gulawani, Sky Bus Of India: 21st Century Innovation In Urban Public Transportation

The SkyBus on the Goa test track. Similar to the JFK Airtrain in New York, SkyBus technology increases the amount of people who can use a transportation right-of-way without increasing congestion. Image used with permission of SkyBus-Atrilab.

The SkyBus technology, developed by AtriLab-Konkan Railway Corp., was first tested in 2004 on a 1 mile trail trial track in Goa, India.[95] SkyBus cars travel in pairs and hold 300 people at a time. SkyBus stations are designed to hold 3 sets of SkyBus trainsets at a time to decrease boarding times and delays.[96] Recent estimates indicated that the SkyBus will have a maximum speed of around 70mph and have a frequency of service/headway of as little as 60 seconds.[97] The SkyBus technology has been approved by the Indian government and SkyBuses are scheduled to open in Hyderabad and Pune in 2009.[98]

95 Staff, "India's sky bus awaits policy, investment push," Indo-Asian News Service. 17 January, 2005

96 Rajaram, B., "SkyBus Metro: Standard Gauge High Speed Railway System," Document dated 31/10/2007, provided by B. Rajaram, AtriLab

97 ibid.

98 Staff, "Skybus to become reality in two years," Daily News and Analysis India, Sunday, April 15, 2007

Aerobus, in contrast, uses high-tension suspension wires like those employed by the Brooklyn Bridge, thus reducing the number of supports that must be placed on the ground. However, despite small scale successful tests of the AeroBus technology (a Canadian ski resort and a 6 month exposition in Mannheim, Germany in the 1970's), AeroBus exists only in prototype form and has never been developed on a commercial or large scale.[99] In the 1980's development began on a 7 mile AeroBus system in Kuala Lampur but financing fell through ending the project. In 1992, AeroBus in conjunction with Milwaukee County (WI) was approved by the Federal Transportation Administration to receive an as-of-yet unfunded federal grant to develop the system. An Aerobus system is scheduled to open in Weihai, China in 2010.[100]

Examples and Opportunities in New York City:

New York City's high population density, significant degree of subterranean infrastructure, coupled with its already substantial public transportation infrastructure and mode-split, suggest that streetcars in New York would play a very different role than those in cities like Portland. The existing density, infrastructure and traffic congestion in Manhattan makes the introduction of streetcars in most of that borough untenable; the already high subway and bus coverage would make streetcars there unnecessary. However, streetcars could be explored as feeder services in less densely developed areas that currently lack rail transit options. The storage of streetcars would also need further consideration.

Streetcar service could be explored on Staten Island as a feeder service for the SIRR, along the Brooklyn-Queens waterfront and connecting to LaGuardia Airport, and crossing the Hudson and Harlem Rivers at 181st Street to connect New Jersey suburbs to the New York City subway system and provide connections to the A, 1, 4, B, D, 2, 5 and 6 trains.

99 AeroBus Website; "Gerhard Mueller—the Creator of Aerobus;" AeroBus; (http://www.aerobus.com/history.html); Accessed 11/08/07

100 Email Correspondence with Dennis Stallings, President, Aerobus, 11/20/2007