FEHR✜PEERS

TECHNICAL MEMORANDUM

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To: Dolores Roybal and Lia Yim, LA Metro

From: Brandon Haydu and Matt Benjamin, Fehr & Peers

Subject: Bike Share Fleet Mix Analysis

LA16-2889

Metro is in the process of expanding the current bike share system located in downtown Los Angeles, Pasadena, Venice, and the Port of Los Angeles. Bike share technology is evolving rapidly and Metro is exploring if and how to incorporate new technologies into the expansion of the bike share fleet.

The existing Metro bike share technology uses a "smart dock" system. A smart dock system incorporates the check-in/check-out technology into the station docks. There are currently three other major bike share technology systems that exist.

1. "Smart Bike": These systems incorporate the check-in/check-out functionality into the bike.
2. "E-Bike": These systems can be either smart dock or smart bike, but offer electric assist to the user. There are currently two forms of E-Bikes, those that are charged by swapping batteries and those that are charged at a charging dock.
3. "Dockless Bike": Rather than locking to a fixed object, a lock engages on the rear wheel to immobilize the bike when not in use. While smart bikes can technically be dockless, this memorandum will consider dockless bikes as low-cost bikes that are privately operated.

There are also other new emerging shared mobility technologies such as electric scooters, velomobiles, and electric kick scooters. This memorandum will focus on smart dock, smart bike, and e-bike systems. Other shared mobility technologies will not be covered because Metro is not currently considering these technologies. This memorandum reviews bike share expansion options that utilize different proportions of technology and provides recommendations on how Metro can expand throughout the county. The document is divided into the following sections:

- Bike Share Technology Overview
- Why Metro Is Exploring New Technology
- Technology Expansion Options
- Preferred Technology Scenario
- Near Term Expansion Schedule

- Technology Flow Chart

After reviewing multiple bike share growth scenarios, we recommend the strategic introduction of smart bikes now as a way to evaluate an eventual transition to a primarily smart bike system. While there are a host of factors that led to this recommendation, there are two primary considerations that strongly favor smart bike technology. These two factors are capital costs and flexibility of technology.

Capital Costs
Due to the additional on-bike hardware, the unit cost of smart bikes is higher than the unit cost of the bikes used in smart dock systems. The lower overall capital costs per bike are achieved by reducing the number of walk-up kiosks and smart docks.   As an example, a smart dock system has approximately one kiosk for every 10 bikes and two smart docks per bike. The proposed ratio for the smart bike system is approximately one kiosk for every 30 bikes and 1.7 docks per bike. Additionally, docks for smart bikes are significantly less expensive than smart docks. This leads to a significant overall reduction in the up-front capital cost, which allows more bikes to be purchased and introduced into the system. The on-going replacement cost for lost and damaged smart bikes will be higher.

Flexibility
Finding sufficient space to install larger smart dock systems is a challenge. Smart bikes are easier to implement quickly because stations areas can be smaller and more flexible in layout/design than smart dock systems. Smart bikes can operate in areas without docks, areas that have smart dock technology, or new areas that don't currently have bike share coverage. Shared mobility technology has been changing rapidly recently and having a system that is flexible to these changes is important with an uncertain future.

An additional, non-technical consideration in favor of the use of smart bikes is that several local agencies have expressed interest in bringing smart bikes to their communities. Feedback and input on technology considerations was also received from Metro, Bicycle Transit Systems, BCycle, and Toole Design Group.

BIKE SHARE TECHNOLOGY OVERVIEW

There are two dominant bike share technologies in use for major metropolitan areas in the United States. These include smart dock and smart bike systems. In addition to these two major technologies, there are other established and newly emerging options such as bicycle libraries, electric assist bicycles, and dockless systems. This section will explain these systems in more detail. The map below shows the current landscape of bike share technology and shows the planned expansion areas for Metro Bike Share.
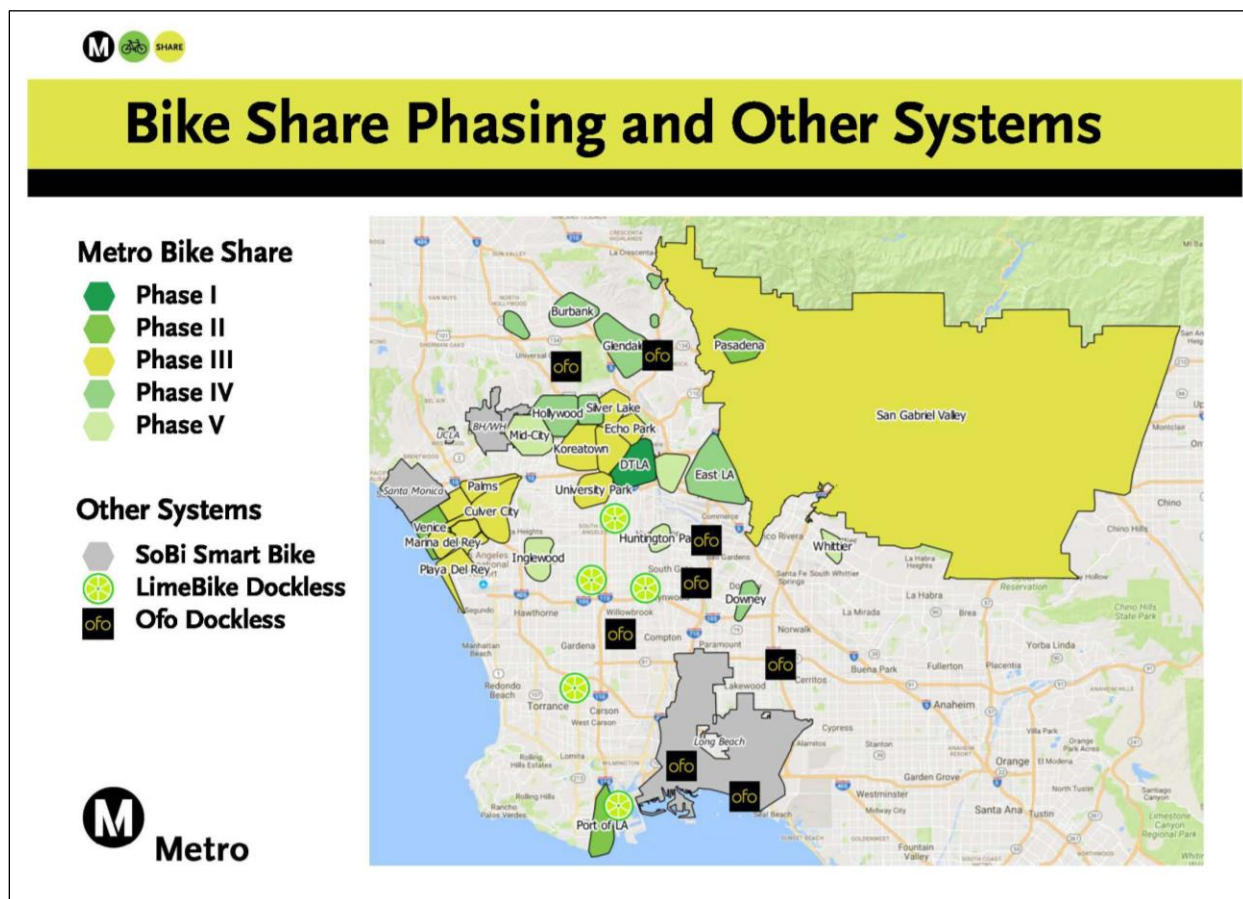
Smart Dock

Metro currently uses a smart dock bike share system. Smart dock systems are the most common form of technology for major metropolitan agencies in the United States. This is partly because smart dock technology has been in production longer than smart bike systems. Smart dock systems started in 1998 and smart bike systems were introduced in 2014. Roughly 85% of all bike share trips in the United States are generated by the five highest-ridership systems, all of which use smart dock technology (New York, Chicago, Washington, DC, Miami, and Boston)[1]. Smart dock systems allow the user to quickly check a bike in/out of a station because the user does not have to manually lock/unlock the bike with a U-Lock. These systems also typically have a larger visual presence than smart dock systems, serving a marketing function and providing users a visual cue that the bikes are a more permanent and reliable travel option.

Smart dock systems generally have higher capital costs than smart bike systems. One reason for this is because the technology is tied to the dock instead of the bike. Common practice is to maintain two docks for every bike. This results in more parts of the system with "smart" technology. These systems can be easier to manage from an operations and maintenance standpoint because bikes are tied to fixed station locations. Having bikes at fixed locations is also convenient because a user can reliably find bikes at nearby docking

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[1] *Bike Share in the US: 2010-2016* (National Association of City Transportation Officials, https://nacto.org/bike-share-statistics-2016/).

stations rather than having to scan sidewalks for parked bikes or search for the nearest bike using a web map or smart phone application.

Smart Bike

Smart bike systems are newer alternatives to bike share and have become increasingly popular throughout the United States. These systems have primarily been implemented in mid-size cities with larger cities including Atlanta, Long Beach, Orlando, Portland, and Santa Monica.

B-cycle, Metro's current bike share vendor, is releasing a smart bike option called Dash. This technology will allow users to begin and end trips outside of designated dock locations and it will not require a kiosk for payment. However, kiosks can be added for areas where walk up access is needed or desired. Smart bike systems can be less expensive from a capital perspective because there is less "smart" technology since everything is integrated into the bikes. Operational costs to maintain a similar number of available bikes at marked locations are unknown because bikes can be distributed outside of marked locations, but incentives are often provided to users to return bikes to marked locations. Using smart bikes is different than using smart dock technology because bikes must be locked with a U-lock. Users may need to locate bikes if they are locked outside of designated stations, and bikes may also be closer to them depending on their location.

Some benefits of a smart bike system is that users may have flexibility to end their trips by locking bikes to standard bike racks within a "geofenced" area around a designated station if the designated station itself is full. This can add flexibility when siting stations because racks can be located near a kiosk but not at a kiosk if space needs to be dedicated to other uses such as parking meters or tree boxes. Users may also be able to end their ride at their destination offering door to door service.

New Bike Share Technology

Bike share technology is changing rapidly in the United States. The first major technology-based systems were implemented in 2010 with smart dock systems in Denver and Washington, DC. Smart bike technology was introduced in 2014 in Phoenix and Tampa. In 2016, three new forms of bike share technology emerged:

1. Dockless bike share systems were introduced in China and have been released in Los Angeles, Dallas, Seattle, and other cities across the US. Dockless bike share systems offer inexpensive bikes that have on-bike, ring locking mechanisms and are not locked to a dock. These systems utilize a QR code to lock/unlock the bike, and users download an application on their smart phone to scan the QR code. These systems can be installed quickly because no stationary infrastructure is needed. Some drawbacks to a dockless system are that bikes are inexpensive and may have maintenance issues. The dockless nature of the bikes also reduces their physical presence, and may look less permanent than current smart dock technology. Because the bikes are not docked, they are more prone to be knocked over, stolen, or placed in undesirable locations such as driveways or walkways. Some advantages to these systems are that they are quick to implement, flexible, and low cost to public agencies. Although, there may be other costs associated with this system for oversight and enforcement. While these dockless systems offer low-cost rides (roughly $1 per ride), they may still have equity issues because they can only be unlocked via a smartphone. Many of the dockless bike share systems are also private companies with substantial venture capital funding. This technology is not currently offered through B-Cycle.

2. Electric assist bike share was introduced in Baltimore and has also been released in San Francisco and Washington DC. Electric assist bike share systems aim to increase the ease of use and range of bikes which can increase the bike shed. Therefore, hilly areas or low density areas may find electric assist bike share to be beneficial. Electric assist bikes might also encourage a wider range of people to use bike share because it takes less effort to ride. These systems will have higher capital costs because electric assist bikes are more expensive. These systems also may need docks that include charging facilities. These systems can utilize smart bike technology and be locked at non-station locations. Charging for these bikes can either be through battery swapping or at designated charging stations. B-Cycle is developing an electric assist smart bike and electric assist smart dock bike that will integrate into current B-Cycle networks.

3. A bike library/rental program was started by Nice Ride in Rochester, Minnesota. Bike libraries are not new in themselves, but integrating them with a bike share system is new. Bike rentals and libraries have been available for many years, but have not been integrated into a bike share system. Nice Ride launched a bike rental program in 2016 as an addition to its traditional smart dock system. The bike rental program provides bikes to residents through local businesses at an hourly rate during business hours. The bikes include 3-speeds, a basket, lights, fenders, and a U-lock. The Nice Ride system has two bike library locations with about nine bikes each. The system generates roughly three trips per day during the week and five to seven rides on weekends. Users are mostly visitors to the Mayo Clinic, hotels, or visitors of residents and most rides are recreational. This structure limits the potential for use because rentals must start and end at the bike rental location.

4. There are also other low cost bike share systems such as Zagster. These lower cost systems are generally used on college campuses, but may be useful for lower ridership areas. These systems are similar to dockless systems in that they use very low cost capital equipment. These systems can either be dockless or can use a low cost station. This is not currently offered through B-Cycle.

WHY METRO IS EXPLORING NEW TECHNOLOGY

Metro bike share is in the early stages of expansion, and bike share technology is changing rapidly. Three member agencies of Metro (Marina del Rey, Culver City, and San Gabriel Valley) have expressed interest in expanding with Dash smart bike technology. Additionally, Metro's service areas has a varied landscape of community types that range from dense, flat landscapes, to hilly but active communities, to lower density suburbs. The bike share technologies outlined in this memorandum have different strengths and weaknesses, and Metro can utilize these technologies to best serve the varied community types within the region. However, an integrated and seamless framework is key to making bike share easy to use and intuitive for users of the system. Therefore, Metro is exploring adding different bike share technology to its fleet so that it can provide the best experience for users of bike share.

Number of Bike Share Systems in the US by Type

Source: NACTO
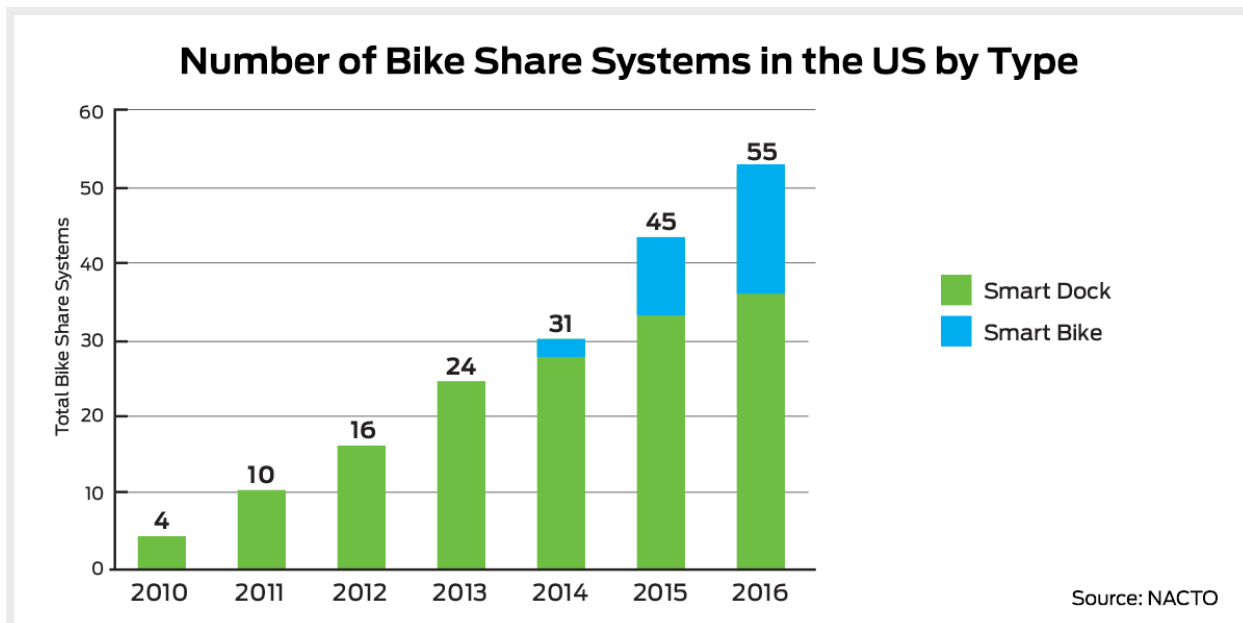
TECHNOLOGY EXPANSION OPTIONS

There are two key technologies (smart dock and smart bike) that are being analyzed for near term expansion, but there are a variety of ways these technologies can be integrated into the Metro bike share system. **Table 1** illustrates the key expansion options using the two primary technologies. These options range from a 100% smart dock system to a 100% smart bike system. There is also an option for a fully integrated system that integrates both technologies. Descriptions of each option is listed below:

- *100% Smart Dock System* – Assumes continued expansion of 2.0 smart dock technology with no integration of smart bikes.
- *Smart Dock System as Default with Smart Bike Offered by Request* – This scenario assumes continued expansion with 2.0 smart dock technology, but flexibility for implementation of smart bike technology in communities that request it (currently Marina del Rey, Culver City, and San Gabriel Valley)
- *Hybrid Approach with 50/50 Smart Dock/Smart Bike Mix* – This system assumes an equal amount of smart bike and smart bike technology to allow users option to choose technology.
- *Smart Bike Expansion with Smart Dock System in Existing Locations* - Assumes smart bike expansion, but keeps existing smart dock technology in place.
- *100% Smart Bike System* – Assumes replacement of current 2.0 smart bike technology with smart bikes and full smart bike expansion.
- *Fully Integrated Smart Dock and Smart Bike System* – Assumes that BCycle develops smart bike technology that allows smart bikes to seamlessly dock/undock into smart docks. This technology is currently not available, but is only a concept.

The systems that emphasize smart dock technology tend to score lower overall because they have difficulty working with other technologies. These systems are also more capital intensive. Systems that focus on a smart bike technology tend to score higher because they can integrate into a changing fabric

of technologies and are less capital intensive to implement. The fully integrated hybrid system, which is a system that would allow smart bikes to dock seamlessly into smart docks, is not being pursued by B-Cycle. Additionally, this system would be very costly as it would be combining the two most expensive components of the smart dock and smart bike systems.

Table 1: Technology Expansion Options

Considerations	100% Smart Dock System	Smart Dock System as Default with Smart Bike Offered by Request	Hybrid Approach with 50/50 Smart Dock/Smart Bike Mix	Smart Bike Expansion with Smart Dock System in Existing Locations.	100% Smart Bike System	Fully Integrated Smart Dock and Smart Bike System
Current Technology Available	Yes	Yes	Yes	Yes	Yes	No
Capital Cost	High	High	Med	Low	Low	High
O&M Cost Per Bike*	Med	Med	Med	Low	Low	Med
Ease of docking/undocking (Monthly)	High	Med	Med	Med	Med	High
Ease of docking/undocking (Walk-Up)	High	Med	Med	Low	Low	Med
Flexibility for User	Low	Med	Med	High	High	High
Ease for Siting / Expansion	Low	Med	Med	High	High	Low
Ease of Use / User Perception	High	Low	Low	Med	High	High
Ability to Adapt to New Technology	Low	Low	Med	High	High	High
GPS Tracking / Other Planning Info.	Low	Low	Med	High	High	High
Integration with Current Technology	High	Low	Low	Med	Low	Med

*O&M costs are high level estimates based on discussions between Metro, BTS and Fehr & Peers and are subject to significant variability.

PREFERED TECHNOLOGY SCENARIO

After reviewing multiple bike share growth scenarios, we recommend the strategic introduction of smart bikes now as a way to evaluate an eventual transition to a primarily smart bike system. There are a variety of benefits to this scenario and the two primary benefits are that there are lower capital costs and there is more flexibility to accommodate changing technology. While ridership per bike between smart bike technology and smart dock technology is unknown, there is no strong evidence that there is a significant difference between systems. However, because capital costs for smart bike technology are significantly lower, with the same budget Metro is able to expand with more bikes within a service area which is shown to increase ridership.

The second key benefit is smart bikes ability to accommodate new technology. A good example of this is the current predicament between 2.0 smart dock technology and Dash smart bike technology. Smart dock technology needs smart docks in order to operate. Smart bikes do not need any technology except for the smart bike itself. While smart bike kiosks are helpful to reach users and branded docks are helpful to organize stations, they are not necessary to operate. Smart bikes can operate within a smart dock environment or within an environment that uses a different vendor. In addition to these two major benefits of a smart bike system, smart bikes also allow more flexibility for the user to ride to locations that don't have stations. Smart bikes also have GPS integrated into the bike which allows more detailed information to be gathered and used for future bike planning.

There are a few cons to smart bike expansion, and the primary drawback is that Dash smart bikes are a relatively new technology. Therefore, some of the operating costs and user experience is yet to be tested in Los Angeles. Smart bikes also use a standard u-lock which allows users to lock a bike anywhere, but the drawback to this technology is that a user also has to use the u-lock at stations. Smart dock systems have fast locking/unlocking and don't require the user to handle a lock. The other drawback to a smart bike system is that it doesn't build off existing technology. This is a minor issue because smart bikes can be placed in smart dock service areas. Below is a list of the key pros, cons, and unknowns with a smart bike expansion.

Pros
- Lower capital costs
- Flexible for user
- Flexible for changing technology environment
- GPS tracking for use in planning
- More flexible station siting allows for more rapid expansion

Cons
- Ease of locking/unlocking bike
- Is different than existing equipment
- Higher replacement cost for lost/damaged bikes

Unknowns
- Operating costs
- Ridership
- User perception of technology

NEAR TERM EXPANSION SCHEDULE

The transition for the smart bike expansion scenario includes beginning expansion of smart bikes in the western service areas (Culver City, Marina Del Rey, Palms, etc.) while maintaining a smart dock system in Downtown, USC, Pasadena, the Port of LA, and Venice. This expansion will keep smart dock bikes in their current locations, and allow smart bikes to expand into new areas. Once smart bike technology has been tested, smart bike expansion will then continue into the San Gabriel Valley, Koreatown, Silver Lake/Echo Park, Westlake/MacArthur Park, and into existing smart dock areas of Downtown. Finally, smart bikes will expand into the remaining identified areas in the City of Los Angeles and other cities who have expressed interest. **Table 2** illustrates the planned expansion schedule.

Table 2: Expansion Schedule

Location	Existing (Phase 1&2) Smart Dock Bikes	Late 2018 (Phase 3) Smart Dock Bikes	Smart Bikes	Mid-Late 2019 (Phase 3) Smart Dock Bikes	Smart Bikes	Late 2019 (Phase 4) Smart Dock Bikes	Smart Bikes	2020 (Phase 5) Smart Dock Bikes	Smart Bikes
DTLA	700	165*			20				
Pasadena	375								
Port of LA	120								
Venice	165	-165*	165						
Marina Del Rey			77						
Culver City			280						
LA - Exposition Park/University Park/USC*		205							
LA - Palms			168						
LA - Playa del Rey			**						
LA - Playa Vista			**						
LA - Del Rey			165						
LA - Mar Vista			165						
LA - Koreatown					370				

Table 2: Expansion Schedule

Location	Existing (Phase 1&2) Smart Dock Bikes	Late 2018 (Phase 3) Smart Dock Bikes	Smart Bikes	Mid-Late 2019 (Phase 3) Smart Dock Bikes	Smart Bikes	Late 2019 (Phase 4) Smart Dock Bikes	Smart Bikes	2020 (Phase 5) Smart Dock Bikes	Smart Bikes
LA - MacArthur Park / Westlake					169				
LA - Echo Park / Silver Lake					252				
Baldwin Park									
Claremont									
Covina									
Duarte									
El Monte									
Glendora									
La Cañada Flintridge									
La Verne									
Monrovia									
Monterey Park									
Pomona									
San Dimas									
South El Monte									
South Pasadena									
West Covina							840		
East Los Angeles							105		
Downey							21		
Burbank							57		
Glendale							161		
LA - Hollywood / East Hollywood							363		
LA - Boyle Heights									127

Table 2: Expansion Schedule

Location	Existing (Phase 1&2) Smart Dock Bikes	Late 2018 (Phase 3) Smart Dock Bikes	Smart Bikes	Mid-Late 2019 (Phase 3) Smart Dock Bikes	Smart Bikes	Late 2019 (Phase 4) Smart Dock Bikes	Smart Bikes	2020 (Phase 5) Smart Dock Bikes	Smart Bikes
LA - Mid-City									150
LA - North Hollywood									80
Huntington Park									70
Inglewood									70
Whittier									28
Total System	**1,360**	**2,585**		**3,396**		**4,943**		**5,468**	

* 165 Smart dock bikes will be moved from Venice to DTLA when smart bikes are introduced to Venice.
** Some bikes from Mar Vista and Del Rey may be moved to these locations.

TECHNOLOGY FLOW CHART

Smart bike expansion is recommended as the preferred scenario given the current technology and information. However, as mentioned previously in the memorandum, bike share technology is changing rapidly and smart bike technology is new for both BCycle, BTS, and Metro. Therefore, the system should be continually monitored to adjust for technological or user challenges. The following flow chart highlights some of the key technological scenarios for expanding with the smart bike technology rollout.

The following metrics should be calculated and included in the evaluation of the first 6-months of smart bike service. Each metric should be reported by type of bike (smart dock or smart bike). More detailed information on these metrics will be provided in a "Measures of Success" memo.

- Rides per bike
- O&M cost per bike
- O&M cost per ride
- Customer support calls (could also compare to first 6-months of 2.0 smart dock system to be fair given that Dash smart bikes are a new product).
- Number of lost or damaged bikes
- Revenue per bike (to account for different user types)

Initial smart bike expansion to Culver City, Palms, Mar Vista, Marina del Rey, and Venice

RIDERSHIP AT 3 MONTHS

Low Ridership
Examine ridership trends and adjust system accordingly

Examine walk-up experiance and consider modifying walk-up interface

High Ridership
Consider possibility of converting smart dock stations to smart bike stations

OPERATIONAL COSTS AT 3 MONTHS

High Costs
Examine O&M costs and adjust system accordingly

Low/Comparable Costs
Move forward with smart bike expansion

USER FEEDBACK AT 3 MONTHS

Negative User Feedback
Examine reasons for poor feeback and adjust system accordingly

Positive User Feedback
Move forward with smart bike expansion

Ridership, Operational Costs and User Feedback at 6 months

Continued Low Ridership, High Costs or Negative User Feedback
Pause smart bike expansion and take a deeper look into how Metro should expand bike share County-wide