Tempe

PUBLIC MEETING AGENDA

Transportation Commission

MEETING DATE
Tuesday, May 12, 2015
7:30 a.m.

MEETING LOCATION
Tempe Transportation Center
Don Cassano Room
200 E Fifth Street, 2nd floor
Tempe, Arizona

MEETING AGENDA

AGENDA ITEM	PRESENTER	ACTION or INFORMATION
1. Public Appearances The Transportation Commission welcomes public comment for items listed on this agenda. There is a *three-minute time limit* per citizen.	Pam Goronkin, Commission Chair	Information
2. Approval of Meeting Minutes The Commission will be asked to review and approve meeting minutes from the April 14, 2015 meeting.	Pam Goronkin, Commission Chair	**ACTION**
3. Streetcar Staff from Public Works and Valley Metro will provide an update on the project.	Eric Iwersen, Public Works, Alec More, Valley Metro, and Michael Kuby, ASU	Information and Possible Action
4. Bike Bait Program Staff will provide an update on the city's bike bait program.	Noah Johnson, Tempe Police Department	Information and Possible Action
5. Orbit fleet Staff will provide the information on the results of the 2013 MiDi bus survey and discuss the possibility of larger Orbit buses on some high demand Orbit routes.	Jason Hartong and Mike Nevarez, Public Works	Information and Possible Action

6. Alameda Drive Bicycle/Pedestrian Design Concepts Project Staff will provide an update on the Alameda Bicycle/Pedestrian Design Concepts Project	Eric Iwersen, Public Works	Information and Possible Action
7. Department and Regional Transportation Updates Staff will provide updates and current issues being discussed at the Maricopa Association of Governments and regional transit agencies.	Public Works Staff	Information
8. Future Agenda Items Commission may request future agenda items.	Pam Goronkin, Commission Chair	Information

According to the Arizona Open Meeting Law, the Transportation Commission may only discuss matters listed on the agenda. The City of Tempe endeavors to make all public meetings accessible to persons with disabilities. With 48 hours advance notice, special assistance is available at public meetings for sight and/or hearing-impaired persons. Please call 350-2775 (voice) or 350-8400 (TDD) to request an accommodation to participate in a public meeting.

Minutes
City of Tempe Transportation Commission
April 14, 2015

Minutes of the Tempe Transportation Commission held on Tuesday, April 14, 2015, 7:30 a.m., at the Tempe Transportation Center, Don Cassano Community Room, 200 E . 5th Street, Tempe, Arizona.

(MEMBERS) Present:

Pam Goronkin (Chair)
Aaron Golub
Nikki Gusz
Jeremy Browning
Ryan Guzy
Bonnie Gerepka
Charles Huellmantel
Philip Luna
Kevin Olson
Charles Redman
Peter Schelstraete
Cyndi Streid
Jonathon Bates
Lloyd Thomas

(MEMBERS) Absent:

Don Cassano

City Staff Present:

Shelly Seyler, Deputy Public Works Director
Mike Nevarez, Transit Manager
Eric Iwersen, Principal Planner
Joe Clements, Transit Financial Analyst
Sue Taaffe, Public Works Supervisor
Amanda Nelson, Public Information Officer
Jason Hartong, Senior Planner
Christine Warren, Senior Civil Engineer
Shauna Warner, Neighbor Program Manager

Guests Present:

Alec More, HDR
JC Porter, ASU
Anne Kurtenbach, HDR
Radu Nan, Kittelson and Associates

Commissioner Pam Goronkin called the meeting to order at 7:32 a.m.

Agenda Item 1 – Public Appearances
None

Agenda Item 2 – Minutes
Chair Goronkin introduced the minutes of the March 17, 2015 meeting and asked for a motion. A Motion was made to approve the minutes.

Motion: Commissioner Philip Luna
Second: Commissioner Nikki Gusz
Abstain: Commissioner Charles Huellmantel and Ryan Guzy
Decision: Approved

Agenda Item 3– Tempe Streetcar
Eric Iwersen introduced Alec Moore, HDR/Valley Metro Project Manager, who presented information regarding the Tempe streetcar project.

Discussion included staff providing an analysis of the pros and cons for two possible street and track configurations for Streetcar along Mill Avenue, from University to Rio Salado Parkway: one in the shared traffic lane and one in what is currently the on-street parking lane on the east side of Mill Avenue, in the northbound direction.

Motion to issue a recommendation to Council to use caution as they consider any changes to the current route and track alignment (share lane) as indicated in the preliminary application.

Motion: Commissioner Kevin Olsen
Second: Commissioner Jeremy Browning
Abstain: Commissioner Charles Huellmantel
Decision: Approved

Agenda Item 4 – CIP Discussion
Shelly Seyler, Deputy Public Works Director, presented the Capital Improvements Program (CIP) budget.

Staff discussed projects recommended to move forward in the Transit CIP process. Staff is waiting on approval of the five year program by Council and there was discussion about whether or not any minor changes will be made by the Council. Staff will present plans to Commission if there are any changes that are made
Motion to recommend to support the CIP Budget that was proposed.

Motion: Commissioner Charles Huellmantel
Second: Commissioner Ryan Guzy
Decision: Approved

Agenda Item 5- Orbit Saturn
Jason Hartong, Senior Planner, presented information on the Orbit Saturn bus route.

Discussion included reviewing phase one comments from the community, introducing four draft Orbit routes and phase two planning for the new Orbit route. Phase two consists of soliciting community input and developing the final proposed Orbit route and service scenario. Next steps include: Community and Transportation Commission meetings for phase three of the process from September 2015 to October 2015 with a presentation to the City Council in Dec. 2015

Agenda Item 6- Bus Unification
Mike Nevarez, Transit Manager, presented information regarding the Bus Unification (Scout Program).

Discussion included the results of the second year finding to date of transit service provided by the Regional Public Transportation Authority (RPTA) through a transit service contract with First Transit Inc. This month, staff will present an update to City Council with additional transit service performance data and a comprehensive financial report that clearly describes the financial outcome of the Scout Program along with a recommendation on the future of the unification project. The Council will be asked in June 2015 to provide direction regarding the future of unification.

Agenda Item 7 – McClintock Drive Mill and Overlay Project
Julian Dresang, Traffic Engineer, provided information on the McClintock Drive Mill and Overlay Project and proposed addition of bike lanes.

McClintock Drive between Broadway and Guadalupe roads will be repaved as part of Tempe's ongoing preventive maintenance program. As part of this repaving project, McClintock Drive will be reconfigured to include bike lanes on each side of the street, which will require the removal of at least one traffic lane on McClintock Drive. A minimum of two vehicular lanes, northbound and southbound, and a middle turn lane will be maintained. A public meeting will be held May 4.

Consensus of support for the project.

Agenda Item 8 – 8th Street Streetscape Project
Eric Iwersen, Principal Planner, provided an update on the 8th Street Streetscape Project.

Staffed discussed the proposed design changes between McClintock Drive and Rural Road. The project will calm the street and enhance the old creamery railroad. There will be additional on street parking and trees. A 10-foot wide multi-use path from Rural to Dorsey is also included in the project. Enhanced pavement treatment like stamped asphalt to indicate the most congested areas. The two-way cycle track will no longer be part of the project.

Motion to support recommendation to Council.

Motion: Commissioner Charles Huellmantel
Second: Commissioner Cyndi Streid
Decision: Approved

Agenda Item 9 – Department and Regional Transportation Updates
None

Agenda Item 10– Future Agenda Items
The following future agenda items have been previously identified by the Commission or staff:

- Streetcar (May)
- Alameda Streetscape Project (May)
- MAG Pedestrian Design Assistance Grants (May)
- Bait Bike Program (May)
- Orbit fleet (May)
- Bus Unification (June)
- City Tentative Fiscal Year 2015-16 Operating Budget (June)
- MAG Congestion Mitigation and Air Quality Program (CMAQ ITS) (June)
- North/South Railroad Spur Multi-Use Path (June)
- Streetcar (June)
- University Drive and Hardy Drive Streetscape project Pre and Post Traffic Count Analysis (June)
- Bike Boulevards (August)
- Highline Canal Multi-use Path (August)
- Bike Share (August)
- Street Closure Procedures and notification follow-up (August)
- Orbit Saturn & Larger Orbit buses (November)
- Alameda Streetscape Project (November)
- Long-Range Forecast Presentation (November)
- Introduction of CIP Requests (December)
- Long-Range Forecast Update (Operating) & CIP follow-up (March)

The Commission's next meeting is scheduled for May 12, 2015.

The meeting was adjourned at 8:59 a.m.

Prepared by: Tammara Evans

Reviewed by: Sue Taaffe, Eric Iwersen

CITY OF TEMPE
TRANSPORTATION COMMISSION

STAFF REPORT

AGENDA ITEM 3

DATE
May 6, 2015

SUBJECT
Tempe Streetcar

At the May 14, 2015 Issue Review Session of the Tempe City Council meeting Valley Metro and Tempe staff will present an update of the Tempe Streetcar project that includes the results of the public process for the Mill Avenue track alignment, from University Drive to Rio Salado Parkway, and the project next steps.

Tempe and Valley Metro staff, during the month of April, conducted outreach to downtown Tempe merchants regarding placing the track for Streetcar in an exclusive curb lane configuration or in the existing travel lane shared with other vehicles. Both configuration pros and cons were shared and discussed with stakeholders. On April 20 the Downtown Tempe Authority made a motion to support the shared lane configuration, based upon the results of the outreach effort. Staff and Valley Metro is seeking direction from the City Council on this item.

RECOMMENDATION
This item is for information and possible input.

CONTACT
Eric Iwersen
Principal Planner
480-350-8810
eric_iwersen@tempe.gov

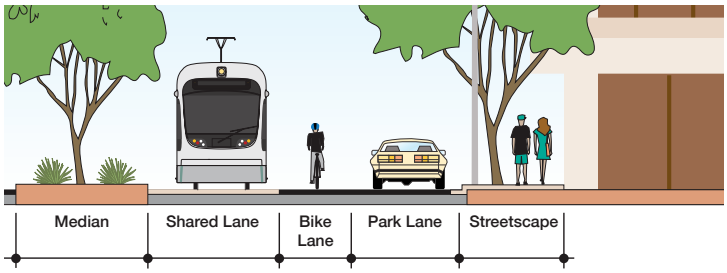
ATTACHMENTS
Business Outreach Survey
Downtown Tempe Authority Letter of Support

BUSINESS FEEDBACK FORM

TEMPE STREETCAR

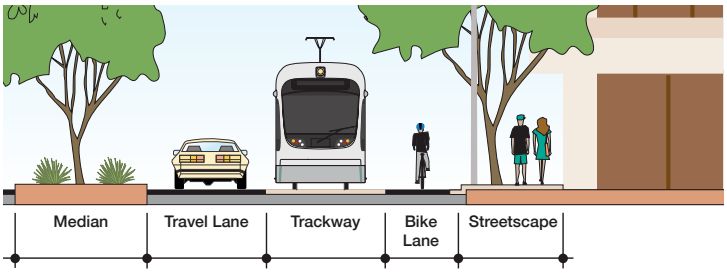
The City of Tempe and Valley Metro are reviewing two options for the Tempe Streetcar lane configuration on Mill Avenue between University Drive and Rio Salado Parkway. Please review the proposed track location maps below and check the box indicating your preference for the location of the streetcar track. In the "Comments" area, please provide the reason for your preference.

Current Option: Shared through-lane



☐ **SHARED THROUGH-LANE:** streetcar would operate in the current travel lane, sharing that lane with auto traffic.

Proposed Option: Curb lane



☐ **CURB LANE:** streetcar would operate in its own lane, created by converting the current parking and loading zone lane, on the east side of Mill Ave., to a transit-only lane.

☐ Either lane configuration is acceptable (no opinion).

CONSIDERATIONS	SHARED THROUGH-LANE	CURB LANE
On-street Parking and Loading Zones	▪ Retains a majority of on-street parking and all loading zones	▪ Eliminates on-street parking (33 spaces) and loading zones (6 spaces) on the east side of Mill Avenue (most parking spaces will be replaced by added side street parking)
Bike Lanes	▪ Provides a continuous bicycle lane	▪ Provides a continuous bicycle lane
Sidewalk and Streetscape	▪ Preserves the existing streetscape (e.g., Ficus trees) ▪ Preserves and enhances existing sidewalk space; allows for possible future widening for outdoor dining area, additional pedestrian space	▪ Removes (at stops) and trims Ficus trees along streetscapes ▪ Generally maintains existing sidewalk, except at stop locations ▪ Precludes possible future widening for outdoor dining areas and streetscape improvements
Service Reliability	▪ Decreased streetcar schedule reliability/travel time	▪ Improved service reliability/travel time
Traffic	▪ Creates minor traffic impacts, including some additional congestion on Mill Avenue in the through-lane ▪ Streetcar shares travel lane with vehicle	▪ Creates minor traffic impacts, including some additional congestion on Mill Avenue in the vehicle through-lane due to additional right turn signal phasing being added to all intersections ▪ Right turning vehicle movements would be made from the through-lane
Construction	▪ Minimizes construction impacts to right-of-way, sidewalks and existing businesses ▪ Requires stop modifications to sidewalk for ADA accessibility	▪ Requires sidewalk reconstruction at stop locations

Comments:

_____

_____

_____

Thank you for your feedback. Please provide the following information.

☐ Check the box if you would like to be added to our database.

☐ Business Owner
☐ Employee
☐ Property Owner

Name: _____ Phone Number: _____

Business Name: _____

Email: _____

Address: _____ City: _____ State: _____ Zip: _____

Please return to Valley Metro at: 101 N. 1st Avenue, Suite 1300, Phoenix, AZ 85003 or email to *akurtenbach@valleymetro.org*. 04-13-15

DOWNTOWN TEMPE

Date: April 21, 2015
To: Mayor Mark Mitchell & City of Tempe Councilmembers
From: Downtown Tempe Authority
Re: Tempe Streetcar

Mayor & Councilmembers,

Our organization is very supportive of the proposed Streetcar as we have stated on several occasions. We believe that the Streetcar makes powerful economic sense as part of a larger growth strategy for Tempe. Downtown is already generating billions in new development and thousands of new jobs for our community and those employees need a transit system. Further, Tempe's future depends on attracting and retaining the next generation of talent who want to live in diverse, high-density areas supported by modern mass transit. The Streetcar is a critical component connecting our newer developments with the heart of our downtown, residents and the student population.

We greatly appreciate the regular updates that we receive from City of Tempe Staff, Valley Metro, and the Mayor himself. Most recently, we were asked to take a position on the lane configuration for the Streetcar. As you are aware, Valley Metro staff canvassed the merchants along Mill Avenue and the majority is supportive of the existing, previously approved configuration with the Streetcar and vehicles sharing a lane. This configuration allows for the retention of parking and delivery zones, a greater number of trees, more sidewalk space and therefore a sense of walkability that favors the pedestrian.

We were very pleased to hear that the project received a "Medium" preliminary rating from the FTA, which is very favorable. Further, we understand that there is a funding gap that the City Council is working to fill. We urge the Council to be stewards of this project and work diligently to mitigate this funding gap. The proposed Streetcar is the next step in a transit system that will serve our community for the next 50 years. This route is phase one and future extensions will enhance the system and meet growth demands. If we allow this project to fail, what is the strategy for maintaining accessibility around our downtown as we add thousands of employees into the district? Without a plan for the future growth of our city's core, we will be handicapped and potentially lose development opportunities to other competitive cities.

We are grateful for the efforts of the Council and City of Tempe staff to deliver the best possible project and usher it through to completion.

Respectfully,

E. Kate Borders, President/Executive Director

SCHOOL OF Geographical Sciences & Urban Planning
ARIZONA STATE UNIVERSITY

To: Tempe City Council

From: ASU Wireless Streetcar Advisory Group

- Michael Kuby, PhD, Professor, School of Geographical Sciences and Urban Planning (mikekuby@asu.edu; 602-750-9907)
- Ellen Stechel, PhD, Professor of Practice, Department of Chemistry and Biochemistry (Ellen.Stechel@asu.edu; 505-400-4299)
- Mikhail Chester, PhD, Assistant Professor, School of Sustainable Engineering and the Built Environment (mchester@asu.edu; 510-332-0145)

Date: May 4, 2015

Re: Findings and Recommendations of ASU Wireless Streetcar Advisory Group for May 14 Council Meeting

Thank you for the opportunity to study the wireless propulsion options for the proposed Tempe Streetcar and to report our findings and recommendations at the upcoming May 14 City Council meeting.

Attached are two documents for your perusal.

1. Our brief presentation to Council. This short version is what we will display and discuss at the Council meeting.
2. A longer annotated version of the same presentation, with more detailed documentation and explanation. In lieu of a formal report, this annotated version explains each slide in greater depth and provides sources and hyperlinks for those who wish to investigate further. The longer version includes information that we do not have time to present at the Council meeting, such as details about the technologies and the status of new wireless streetcar projects in Dallas, Detroit, and Seattle.

We hope you find this report helpful, and we look forward to answering any questions you may have.

Report by Wireless Streetcar Advisory Group City of Tempe

May 14 City Council Meeting

Dr. Ellen Stechel, Professor of Practice, Department of Chemistry and Biochemistry, and Deputy Director, LightWorks, ASU

Dr. Michael Kuby, Professor, School of Geographical Sciences and Urban Planning, ASU

Dr. Mikhail Chester, Assistant Professor, School of Sustainable Engineering and the Built Environment, ASU

Executive Summary

* At least one **"win-win"** wireless streetcar technology exists that is**:**
  - Commercially available
  - Suitable for Tempe alignment, hours, and climate
  - Less expensive (net capital cost savings of $7 to 8 million)
  - Reduces local funding gap, thus improving chance of FTA funding
  - Attractive and exciting
  - Safer
  - More sustainable
  - Integrates proven technologies
* Report assesses risk (technological & financial) and mitigation strategies

Overhead Wires…?

TUSCON, AZ

https://www.facebook.com/TucsonStreetcar/photos/a.529741690435796.1073741844.147598338650135/531448610265104/?type=3&theater

11

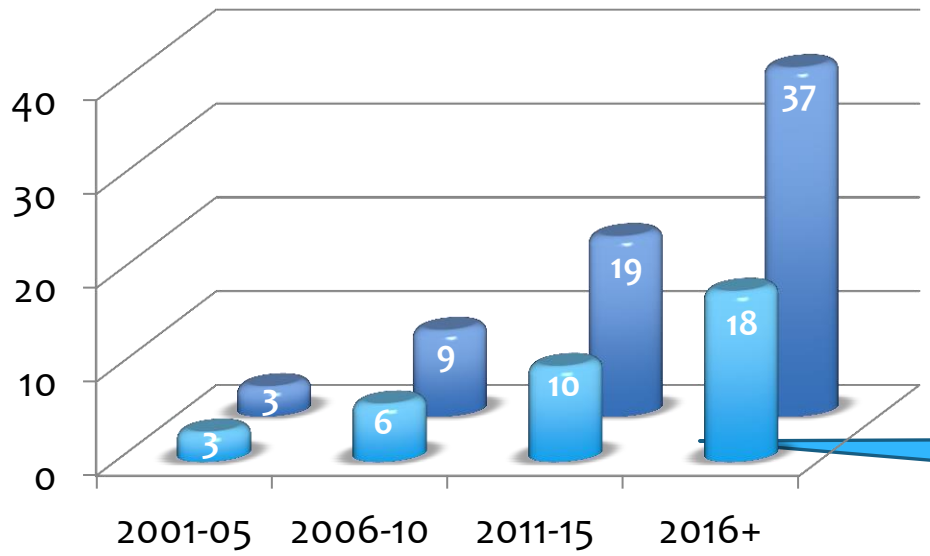
… or Wireless?

http://1.bp.blogspot.com/_K78YS2Yiswo/TUTAkF8tK2I/AAAAAAAADbw/CTKw_0MAW_A/s1600/800px-Nice_tramway_place_Garibaldi.jpg[12]

Cities Worldwide are Innovating

Substantial Progress Made Since Initial Propulsion Technology Assessment

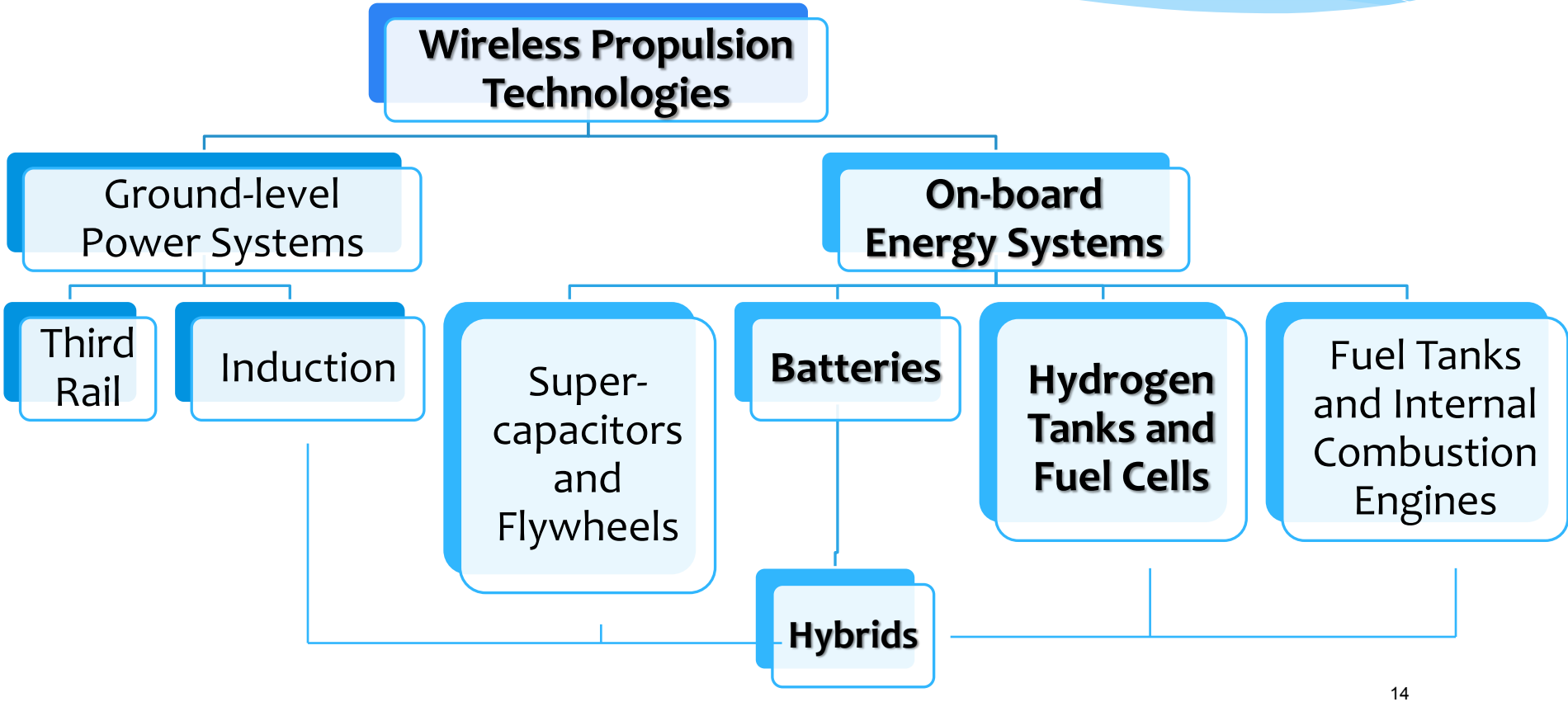
Worldwide Wireless Streetcar Systems
(for at least part of route)



Planned or Under Construction

Wireless Propulsion Contenders

(Substantial progress and multiple options being deployed globally, since initial Valley Metro assessment)



Many Cities and Manufacturers Going Wireless Using Ground-Level Power

Technology	Manufacturers	Cities (year built) * = On order, H = Hybrid	Wireless Length
In-ground 3rd rail (conduction)	Alstom, Ansaldo	Bordeaux (2003), Angers (2011), Rheims (2011), Orleans (2012), Tours (2013),Dubai (2014), Naples*	½ to 17
Induction from transmitters in railbed	Bombardier, TIG/m, Wampfler	The Grove, CA (2002)H, Augsburg (2012), Nanjing (2014), Dallas (2015)H	½ to 1 mile

On-Board Energy Systems Around the World

Technology	Manufacturers	Cities (Year built) * = on order, H = Hybrid with Batteries	Wireless Length
Super-capacitors	Bombardier, Alstom, CAF, Siemens, Vossloh	Mannheim (2003), Lisbon (2008)[H], Paris (2009), Savannah (2009),[H] Seville (2010)[H], Zaragoza (2011)[H], Florence*, Guangzhou*, Rotterdam*, Granada*, Kaohsiung,* Leon*, Rostock*, Portland*, Qatar*[H]	¼ to 2.5 miles
Flywheels	Parry People Mover	Stourbridge (2009)	
Batteries (Lithium except where noted)	Alstom, Ansaldo, Bombardier, CAF, Kawasaki, Siemens, Stadler, TIG/m, Gomaco, Inekon, Brookville, Kinki Sharyo	The Grove, CA (2002)[H], Nice (2007 – *NiMH battery*), Munich (2011), Nanjing (2014), Dallas (2015), Seattle*, Detroit*, LA*, Brasilia*, Nordhausen (Germany)*, Dubai*	¼ to 5 miles
Fuel tanks	Siemens,TIG/m (LPG, LNG, CNG, diesel)	Nordhausen*, Qatar*	Far
Fuel cells (H_2, CH_3OH)	CSR Sifang, FEVE, TIG/m	Dubai (2015)[H], Qingdao*[H], Aruba*[H], Hermann-Hesse*[H]	9 miles

16

Battery-Powered Segment
Just Opened April 2015, Dallas, TX

http://www.tautonline.com/dallas-streetcar-opens-for-service/

17

Wireless Technologies - Limitations

	Wayside power for full route	Higher capital costs	Lacks energy for 20 hours	Size & weight	Does not work under water	Longer station dwell times	Vehicle emissions	Slow charge times	Under-powered if used alone
Ground-Level									
In-ground contact rail	X	X			X				
Wireless induction	X	X							
On Board									
Super capacitors	X	X		X					
Flywheels	X	X		X		X			
HC Fuel tanks							X		
Batteries			X	X				X	
Fuel cells									X
Battery-Fuel Cell Hybrid									

18

A Commercially Available Self-Powered Technology Exists

Self-powered through hybridization of:

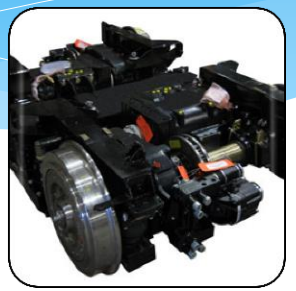
* Overnight battery charging (off-peak)
* Regenerative braking
* On-board hydrogen tanks and fuel cells

Combines technologies proven in:

* Automotive
* Rail
* Forklifts
* Remote locations
* Space program

Completely eliminates substations, transformers, high-voltage electricity, and overhead or underground wires for entire 3.1 mile route.

TIG/m On-Board Hybrid Propulsion System is Based on Proven Components



H_2 Tanks

H_2

Fuel Cells

Battery

Electric Motor and Wheels

Regenerative Braking

H_2

H_2 Station

Overnight

Smart Integration of Technologies

* Regenerative braking great for stop-and-go streetcar
* Fuel cell well suited for recharging battery—less challenging than for traction
* Battery warranty doubled by avoiding deep cycling
* Fuel-cell for range extension is well suited to rail
  - Rail has less rolling resistance than bus or automobile
  - Rail needs only one centralized hydrogen station

Appears to Meet Valley Metro and FTA Specs

* Confirmed by Dec. 22, 2014 conference call with Valley Metro and TIG/m CEO
* Further confirmation in Mar. 8, 2015 conference call with ASU Group and TIG/m CEO
* 80% low-floor (heavy batteries under elevated driver's seat and rear seats)
* Buy American – TIG/m headquartered in Southern California
* Meets all European specs – generally tougher than US specs
* **Proof of Existence – If RFP is issued, <u>at least</u> one company will be able to meet the criteria and prepare a compliant bid**

Overhead Transmission Wires are Ugly But Also Expensive and Unnecessary

Element	Year of Expenditure $ TOTAL (Million)
Traction power - substations	$ 7.5
Traction power- catenary	$ 11.1
Total Electrical	**$ 18.6**

Source: Tempe Streetcar _SCC_Workbook_Rev_16_SMALL_STARTS_021315.PDF

Different Style TPSS

Capital Cost Tradeoffs (rough estimates)

Cost Savings	($ millions)	Cost Increases	($ millions)
Wayside power systems	- $18.5	Vehicles (Est $0.5 million more per vehicle x 6)	+ $3.0
		Hydrogen Station	+$1.25
		Battery Replacement x 7 (10/20 yrs)	+ $1.2
		Spare streetcar	+ $5.4
TOTAL SAVINGS	**- $18.5**	**TOTAL INCREASE**	**+ $10.85**

Net capital savings of roughly $7.65 million (helps to close funding gap) plus aesthetic and reputation benefits.

Environmental Tradeoffs

Positive Impacts	No Impact	Negative Impacts
Lower grid energy use and carbon emissions (if solar power is used to generate hydrogen)	No emissions from vehicles for either option (except pure water vapor)	Greater grid energy use and carbon emissions (if grid electricity is used to generate hydrogen)
Reduced "visual pollution"	No change in equity across groups (same route, same populations served)	
Fewer tree trimming or removal – more shade		

Safety Tradeoffs

Positive Impacts	Negative Impacts
Safer for firefighters – no ladder trucks near wires	Risk of hydrogen fire at H_2 station or vehicle
No downed live wires from storms or crashes	
No substation/transformer explosion risk	

Safety Risk Assessment

* Hydrogen is 14X lighter than air and stored above ceiling of streetcars – any release goes up
* Hydrogen station isolated at light-rail maintenance yard
* Hydrogen permitting standards: www.hydrogen.energy.gov/permitting/fueling_stations.cfm
* Tempe Firefighters and Valley Metro staff will need training in dealing with hydrogen

Partner with Center for Transportation and the Environment

* Since 1993, CTE has managed $290 million of clean, sustainable, innovative transportation and energy technology projects
* CTE can produce detailed modeling of energy and cost for specific route, location, vehicle, and rate structure, usually +/- 5% (contract cost would be $60K-$75K)
* CTE is trusted by FTA as honest, 3rd party evaluator of new technology
* CTE routinely works with FTA, DOT, DOE, DOD, NASA
* CTE has on staff engineers, economists, lobbyists, project managers
    - Project Planning
    - Grant Writing
    - Technical and Lifecycle Evaluation
    - Technical Specifications
    - Inspection
    - Deployment Oversight
    - Performance Monitoring
    - FTA Reporting

Preliminary Risk Assessment and Mitigation

Risk	Mitigation
What if company goes out of business?	• A risk even for established companies • Purchase insurance to cover future maintenance
What if on-board systems don't generate enough power?	• Shouldn't happen – easily modeled by manufacturer and CTE • Require a performance guarantee in contracts • Could design with extra capacity at the station, tanks, fuel cells • Fuel cell buses have seen little to no degradation or maintenance over 9,000-15,000 hours • Mobile hydrogen delivery to vehicles en route is possible
What if streetcars cost more than estimated?	• Not an issue with a fixed-price contract
Few vendors and limited experience	• Vendors really want that first US customer • Several companies now implementing hydrogen fuel cells w/ or w/o batteries in a wide range of vehicles and stationary power • Hydrogen production with electrolyzers is not new and is growing

Potential Risks to Funding

Risk	Mitigation
FTA prefers proven technologies	• FTA doesn't exclude off-wire technologies • Individual component technologies all proven • Integration of technologies also proven, just not on a streetcar in revenue service • FTA trusts CTE as honest 3rd-party broker • CTE managed 4 of 10 projects recently funded by FTA
FTA prefers US testing	• "Laws of physics are the same everywhere"
FTA funding contingent on local match	• By reducing capital costs by $7 to 8 million, FTA funding prospects will improve substantially
Changing propulsion now might delay FTA application	• Propulsion system does not have to be specified at this time • Environmental clearances can be modified • RFP could be broad enough for multiple bids (e.g., Seattle specified battery and/or super capacitor—but better to specify required attributes and not specify the technology) • Tempe would need representation on review committee to choose best bid
Delay may allow other Valley cities to leapfrog Tempe	• This is a political question beyond the scope of our study

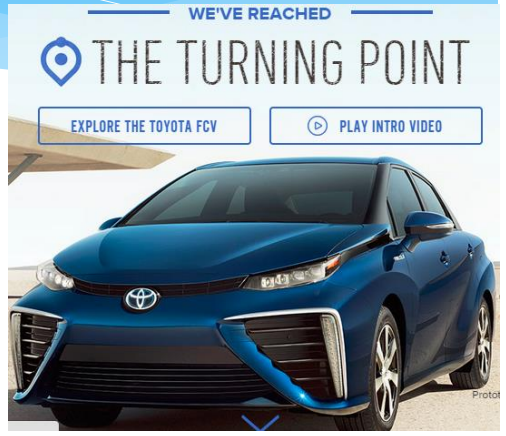
29

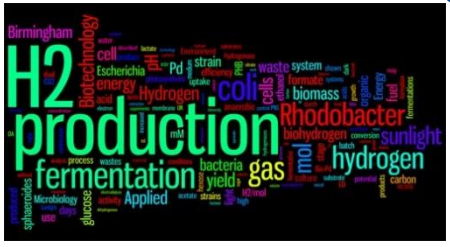
Intangible Benefits

CALIFORNIA HYDROGEN BUSINESS COUNCIL

Connecticut Hydrogen-Fuel Cell Coalition

* Striking aesthetics
* Faster construction/less disruptive to business
* International reputation for innovation
* Study tours from other cities
* High-tech start-up companies
* Jumpstart on the hydrogen economy
* Valley Metro already a national leader in alt fuels
* Solar-hydrogen partnerships with ASU, APS, SRP, First Solar
* Removable streetcar windows (TIG/m)





Conclusions

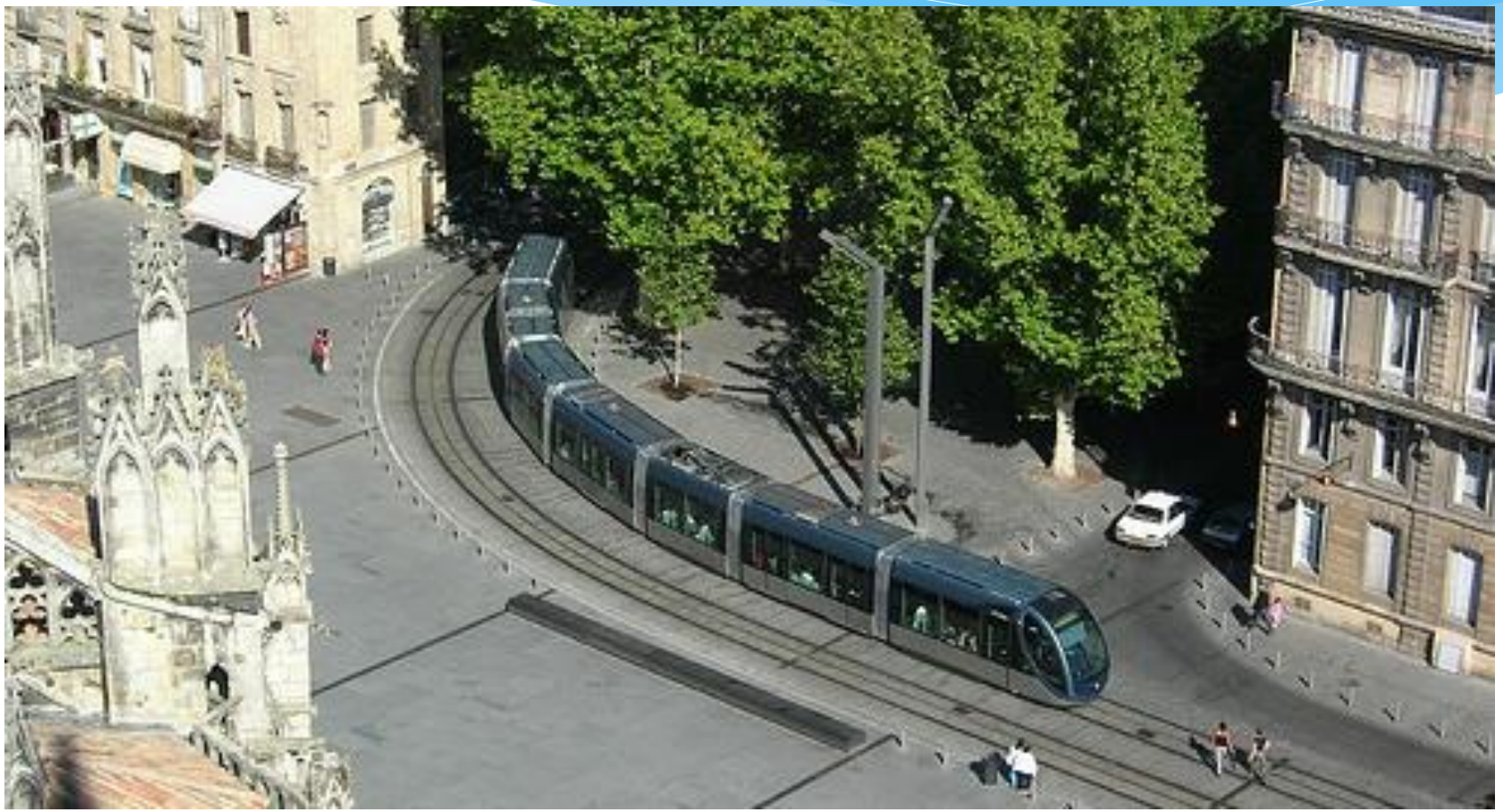
* Proof of existence that at least one **"win-win"** self-powered streetcar technology is commercially available and**:**
  - More attractive and more exciting
  - Suitable for Tempe route, hours, and climate
  - Net capital cost **savings** in neighborhood of $7 to 8 million
  - Safer and more sustainable
  - Integration of proven technologies
* There are ways to manage technological, perception, and financial risks through partnering with CTE, open RFP, careful contracting, insurance, additional performance margins, and contingency planning
* Reducing the funding gap improves chance of FTA funding

31

Recommendations

* Work with Valley Metro to continue advancing a proposal for FTA funding while keeping propulsion options open.
* Budget $60 to 75K for CTE to do cost and energy modeling of battery/fuel cell hybrid system and other wireless streetcar technologies for Tempe route and climate.
* With CTE's 3rd-party analysis in hand, partner with CTE and Valley Metro to engage with FTA and build FTA support.
* Begin developing appropriate RFP specifications and performance guarantees that would allow multiple vendors to propose competing technologies for a completely self-powered (or with extensive wireless segments) streetcar system with no high-voltage power requirements that would reduce capital costs, assess and mitigate risks, and help close the funding gap.

Questions?



Appendix 1
ASU Study Group Members

Dr. Ellen Stechel

Dr. Ellen Stechel is a Professor of Practice in Chemistry and Biochemistry at ASU, and Deputy Director of LightWorks. Prior to coming to ASU, she managed research departments in solar and emerging energy technologies at Sandia National Laboratories and before that at Ford Motor Company managing Chemistry and Environmental Science in the Scientific Research Laboratory and proving/deploying new low-emissions technologies in Ford Product Development, which included Ford's hybrid vehicle.

Dr. Stechel earned her PhD in Chemical Physics from University of Chicago.

Dr. Michael Kuby

Dr. Michael Kuby is Professor in Geographical Sciences and Urban Planning at ASU, and Director of the Interdisciplinary Graduate Certificate Program in Transportation Systems. He specializes in alternative-fuels vehicles and infrastructure and light-rail ridership. He has co-edited the last two Background Reports on Transportation for the Arizona Town Hall. He is Location Area Editor for the journal *Networks and Spatial Economics* and on the editorial boards for *International Regional Science Review* and *Journal of Transport Geography.*

Dr. Kuby earned his PhD in Geography from Boston University.

Dr. Mikhail Chester

Dr. Mikhail Chester is an Assistant Professor in Civil, Environmental, and Sustainable Engineering at ASU, where he runs a research laboratory focused on transportation life cycle assessment and infrastructure resilience to climate change. Dr. Chester has worked with a variety of public and private passenger and freight agencies to develop energy and environmental assessments of transportation systems including infrastructure, vehicle, and energy production processes, in addition to vehicle operation.

Dr. Chester earned his PhD in Civil and Environmental Engineering from UC Berkeley.

Report by Wireless Streetcar Advisory Group City of Tempe

May 14 City Council Meeting

Dr. Ellen Stechel, Professor of Practice, Department of Chemistry and Biochemistry, and Deputy Director, LightWorks, ASU

Dr. Michael Kuby, Professor, School of Geographical Sciences and Urban Planning, ASU

Dr. Mikhail Chester, Assistant Professor, School of Sustainable Engineering and the Built Environment, ASU

Executive Summary

* At least one **"win-win"** wireless streetcar technology exists that is**:**
  - Commercially available
  - Suitable for Tempe alignment, hours, and climate
  - Less expensive (net capital cost savings of $7 to 8 million)
  - Reduces local funding gap, thus improving chance of FTA funding
  - Attractive and exciting
  - Safer
  - More sustainable
  - Integrates proven technologies
* Report assesses risk (technological & financial) and mitigation strategies

Overhead Wires…?

TUSCON, AZ

https://www.facebook.com/TucsonStreetcar/photos/a.529741690435796.1073741844.147598338650135/531448610265104/?type=3&theater

… or Wireless?

http://1.bp.blogspot.com/_K78YS2Yiswo/TUTAkF8tK2I/AAAAAAAADbw/CTKw_0MAW_A/s1600/800px-Nice_tramway_place_Garibaldi.jpg[38]

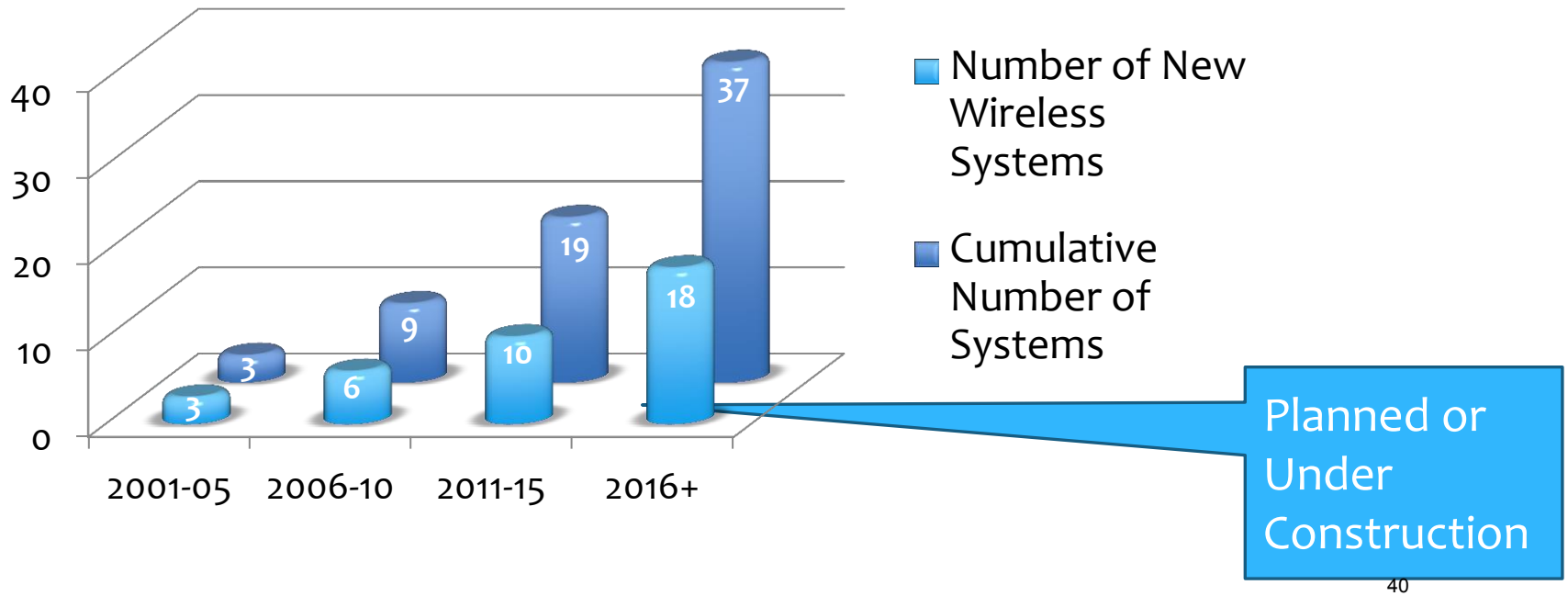
Overhead Wires vs. Wireless
Additional Notes

* Nice, France neighbors Tempe's Sister City, Beaulieu-sur-Mer
* According to Swanson (2013) :
  * **"One thing is certain: public opinion is very supportive of wireless or off-wire systems for aesthetic reasons. As this technology becomes even more mature and available, widespread adoption is inevitable."** (p. 189)
* Swanson, John D. (Parsons Brinckerhoff). 2013. Practical Off-Wire Streetcar/Light Rail Operation. In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 181-189, http://trid.trb.org/view.aspx?id=1298693.

Cities Worldwide are Innovating

Substantial Progress Made Since Initial Propulsion Technology Assessment

Worldwide Wireless Streetcar Systems
(for at least part of route)

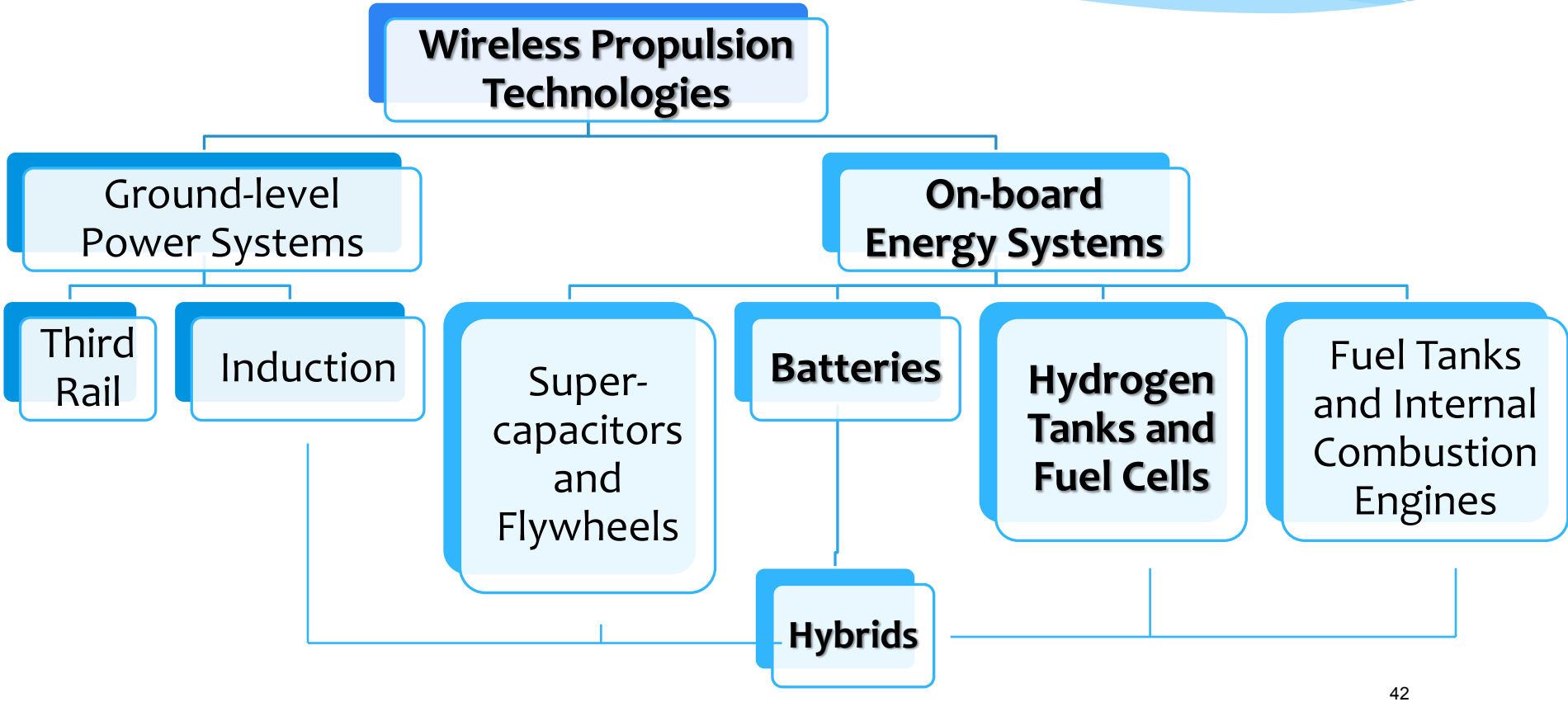


Cities Worldwide are Innovating
Additional Notes

* Bars represent number of new systems opened in each 5-year period.
* The main sources for information on the existing, under construction, and planned systems on this slide and the following tables were:
  * Wilbur Smith Associates., Streetcar Technology. http://www.kimley-horn.com/Projects/fasttrackfresnocounty/downloads/StreetCarInfo/streetcars%20technology3%20%282%29.pdf
  * Swanson, John D. (Parsons Brinckerhoff), 2013. Practical Off-Wire Streetcar/Light Rail Operation . In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 181-189.
  * HDR, Inc., Comprehensive Assessment on Streetcar Propulsion Technology.,Prepared for Council of the District of Columbia and District Department of Transportation, 31 July 2014.
  * HDR, Inc., Union Station to Georgetown Alternative Analysis for Premium Transit Service Propulsion Study, Final Report, September 2013.
  * Porter, Denny and Ethan Melone, 2013, The New Seattle Streetcar with Onboard Energy Storage. In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 190-200.
  * Bowen, D. J. , Here come the streetcars, *Railway Age* (April 8, 2013), http://www.railwayage.com/index.php/passenger/light-rail/here-come-the-streetcars.html.
  * Railway Gazette. http://www.railwaygazette.com/news/.
  * Tramways & Urban Transit. http://www.tautonline.com/.
  * Wikipedia (various topics).
  * Test-track systems not used in revenue service, such as in Sapporo Japan, are not included in these counts, but their manufacturers are listed.
  * Hybrid systems listed under more than one technology in the following slides are counted only once in this bar chart.

Wireless Propulsion Contenders

(Substantial progress and multiple options being deployed globally, since initial Valley Metro assessment)



Ground-Level Power
Additional Notes

* This classification scheme comes from Swanson, John D. (Parsons Brinckerhoff). 2013. Practical Off-Wire Streetcar/Light Rail Operation. In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 181-189, http://trid.trb.org/view.aspx?id=1298693.
* Ground-level power:
  * Can be divided into conductive (requires physical contact) and inductive (transmitted wirelessly). Both provide continuous power over the entire route. Conductive systems are best known as a "3rd rail," which in streetcar systems is depressed below street level. Inductive systems have some kind of coils or wires in the rail bed that transmit electromagnetic radiation, which is received by coils below the vehicle passing over it.
  * Is considered safe. Today's systems turn on only when the rail vehicle passes over them.
  * Is generally more expensive than overhead power. All of the capital costs of providing high-voltage electricity along the entire route, including transformers and substations, remain.

On-Board Storage
Additional Notes

* Depending on the types and amounts of energy storage, and how quickly they can be refilled, on-board systems can be filled:
  * Overnight at the rail maintenance facility
  * At one or both ends of the line when the rail car might sit for 5-10 minutes
  * At every station, in less than 1 minute.
* On-board energy systems include:
  * Super capacitors "are used in applications requiring many rapid charge/discharge cycles rather than long term compact energy storage: within cars, buses, trains, cranes and elevators, where they are used for regenerative braking, short-term energy storage or burst-mode power delivery. " They charge and discharge much faster than batteries, but are up to 10 times larger than conventional batteries. They were developed in the 1950s and 60s by GE and Standard Oil of Ohio. (http://en.wikipedia.org/wiki/Supercapacitor).
  * Flywheels are rotating mechanical devices that store kinetic energy in the form of a large rotating wheel. Electrical energy at a station is used to spin the wheel faster, and then this spinning energy is used to drive the wheels to get to the next station (http://en.wikipedia.org/wiki/Flywheel). Auxiliary power may be required.
  * Rechargeable batteries convert electrical energy into chemical energy through an electrochemical reaction. The chemical energy is then converted back to electrical energy. Recharge batteries come in many forms, each with different characteristics in terms of cost, storage capacity, charging and discharging speed, performance in different climates, weight, cost, and degradation. Major types include nickel metal hydride and lithium, including several different kinds of lithium batteries. (http://www.afdc.energy.gov/vehicles/electric_batteries.html and http://www.proterra.com/proterra-introduces-extended-range-electric-bus-flexible-battery-system/).
  * Fuel tanks and internal combustion engines , which need little explanation, can also be used to power a streetcar, but in addition to pollution from the vehicles, electric motors provide more powerful traction than internal combustion, so these combustion systems for rail typically power a generator that produces electrical energy for traction.
  * Continued on next slide

On-Board Storage (Hydrogen)
Additional Notes

Other on-board energy systems include:

* Fuel cells can be thought of as similar to batteries but with a continual feed of chemical energy that they convert to electrical energy, so they do not run down or need recharging. Pure hydrogen is the most common form of chemical energy (fuel) used in fuel cells, but they can also run on hydrogen-rich fuels such as methanol or natural gas. In a hydrogen fuel cell, pure hydrogen and oxygen are combined to form electricity and water. Water vapor is the only emission. Fuel cells were first invented in 1838. The first commercial use was in the most demanding conditions: the NASA space program. Fuel cells generate virtually all electricity for space missions, and astronauts drink the water that is formed as a byproduct of generating the electricity. Fuel cells today tend to be 40-65% efficient. Fuel cells can be scaled up or down to any size from a cellphone battery to utility-scale power generation, in what is called a fuel cell "stack." See http://energy.gov/eere/fuelcells/types-fuel-cells, http://www.afdc.energy.gov/fuels/hydrogen_basics.html, http://en.wikipedia.org/wiki/Fuel_cell, and http://energy.gov/eere/fuelcells/downloads/state-states-fuel-cells-america-2014.
* Technologies for generating hydrogen are also not new, and have been in commercial usage for decades. See later slide on Off-Vehicle Supportive Energy Systems.
* The hydrogen for fuel cells is typically stored in high-pressure metal bottles or cartridges. Much research is being conducted to find cheap ways to store hydrogen more compactly, but this is not really an issue for streetcars, where the hydrogen would be stored in metal bottles on top of the vehicle (between the interior ceiling and the outer roof). Hydrogen is the smallest and lightest chemical element, 14 times lighter than air, so storing it above the streetcar is an ideal solution. Hydrogen combines rapidly with other elements, so it cannot be "mined" from the earth or the atmosphere. Hydrogen must be extracted from other molecules, which requires energy. For a streetcar, hydrogen would be generated at a dispensing station at the rail maintenance facility.
* Hydrogen fuel cells are rapidly finding commercial applications. Bloom Energy is building fuel cells for backup and remote power stationary applications (http://www.bloomenergy.com/). Fuel cells have been demonstrated extensively on transit buses in revenue service. The Hyundai Tucson SUV (https://www.hyundaiusa.com/tucsonfuelcell/) and Toyota Mirai sedan (http://www.toyota.com/mirai/) were introduced in 2014-15 as the first FCVs being sold to consumers in select markets in California, Korea, and Japan where hydrogen fueling station deployment makes consumer adoption possible. Honda, as well as US and German auto manufacturers, are set to follow in 2016-17. Walmart and others are using forklifts powered by hydrogen fuel cells (http://247wallst.com/energy-business/2014/07/29/plug-power-squeezes-even-more-out-of-walmart/), and fuel cell motorcycles are also hitting the market (http://www.intelligent-energy.com/automotive/case-studies/suzuki).

Many Cities and Manufacturers Going Wireless Using Ground-Level Power

Technology	Manufacturers	Cities (year built) * = On order, H = Hybrid	Wireless Length
In-ground 3rd rail (conduction)	Alstom, Ansaldo	Bordeaux (2003), Angers (2011), Rheims (2011), Orleans (2012), Tours (2013),Dubai (2014), Naples*	½ to 17
Induction from transmitters in railbed	Bombardier, TIG/m, Wampfler	The Grove, CA (2002)H, Augsburg (2012), Nanjing (2014), Dallas (2015)H	½ to 1 mile

Ground-Level Power
Additional Notes

* The wireless length is the distance that the rail cars cover without overhead wires. Some of these distances in this and the following slide are based on page 4 of the propulsion study done for Washington, DC: HDR, Inc. Union Station to Georgetown Alternative Analysis for Premium Transit Service Propulsion Study, Final Report, September 2013.
* The ***** indicates that the system is planned or under construction.
* The H indicates a hybrid system with two or more forms of energy other than overhead catenary systems (OCS). In these slides, we are *not* counting systems that combine OCS with another technology as hybrids. Hybrids, like hybrid cars, usually combine batteries with something else, such as internal combustion, fuel cells, induction, third rail, super capacitors, or flywheels.
* For ground-level power systems, the wireless length is largely a function of cost, not technology. Ground-level power systems could move a streetcar as far as desired because they provide continuous power. Most subway system around the world use a third-rail conductive system without overhead wires and run for many miles. For streetcars, the wireless length is constrained by affordability, not technology.
* In some cases, induction from transmitters has been combined with on-board energy storage. For instance, the TIG/m system at the Grove retail complex in Southern California and the new system in Dallas use induction in the railbed to recharge the batteries at certain locations.

On-Board Energy Systems Around the World

Technology	Manufacturers	Cities (Year built) * = on order, H = Hybrid with Batteries	Wireless Length
Super-capacitors	Bombardier, Alstom, CAF, Siemens, Vossloh	Mannheim (2003), Lisbon (2008)[H], Paris (2009), Savannah (2009),[H] Seville (2010)[H], Zaragoza (2011)[H], Florence*, Guangzhou*, Rotterdam*, Granada*, Kaohsiung,* Leon*, Rostock*, Portland*, Qatar*[H]	¼ to 2.5 miles
Flywheels	Parry People Mover	Stourbridge (2009)	
Batteries (Lithium except where noted)	Alstom, Ansaldo, Bombardier, CAF, Kawasaki, Siemens, Stadler, TIG/m, Gomaco, Inekon, Brookville, Kinki Sharyo	The Grove, CA (2002)[H], Nice (2007 – *NiMH battery*), Munich (2011), Nanjing (2014), Dallas (2015), Seattle*, Detroit*, LA*, Brasilia*, Nordhausen (Germany)*, Dubai*	¼ to 5 miles
Fuel tanks	Siemens,TIG/m (LPG, LNG, CNG, diesel)	Nordhausen*, Qatar*	Far
Fuel cells (H_2, CH_3OH)	CSR Sifang, FEVE, TIG/m	Dubai (2015)[H], Qingdao*[H], Aruba*[H], Hermann-Hesse*[H]	9 miles

48

On-board Energy Systems: Batteries
Additional Notes on Dallas Streetcar

* Tramways & Urban Transit, Dallas Streetcar Opens of Service, 16 April 2015, www.tautonline.com/dallas-streetcar-opens-for-service/.
  * The Dallas streetcars are 66-ft, 70% low-floor Liberty design made by Brookville Equipment Corp. Vehicles cost $4.5 million. It uses two 550-volt batteries to cross a bridge over the Trinity River without wires.
  * The wireless section consists of 1 mile of the 1.6-mile route (www.brookvillecorp.com/Brookville-Delivers-Dallas-Streetcar.asp?news=news-streetcar.asp).
  * Dallas' historic preservation committee would not permit the Dallas-Oak Cliff Streetcar line to install overhead wires and poles on the Trinity River Bridge" (www.hntb.com/sites/default/files/HNTB_ITX_OffWireTech_914.pdf).
  * The project cost $57 million and received $26 million TIGER funding from FTA (www.apta.com/resources/hottopics/circulators/Documents/Downtown-Dallas-Streetcar-Fact-Sheet.pdf).
  * Photo gallery is here: https://www.dart.org/newsroom/imagelibrary.asp#DallasStreetcar.
  * Environmental documents are here: https://www.dart.org/about/expansion/dallasstreetcar.asp.
  * Other links can be found here: http://en.wikipedia.org/wiki/Dallas_Streetcar

Battery-Powered Segment Just Opened April 2015, Dallas, TX

http://www.tautonline.com/dallas-streetcar-opens-for-service/

50

On-board Energy Systems: Batteries
Additional Notes on Detroit Streetcar

* M-1 Rail will open its Woodward Avenue streetcar in 2016.
* Over 2 miles of the route will be wireless (60% of length) . The streetcars will operate on-wire between Henry and Canfield, and be off-wire everywhere else on the line.
* Wires would have interfered with Detroit's Thanksgiving Day parade.
* Streetcar vehicles will use lithium ion batteries on off-wire segments.
* Vehicles made by Czech company Inkeon (same as Seattle). Streetcars will be "Buy America" compliant and assembled in Michigan.
* Vehicles will be 73 feet long and 100% low-floor, and weigh 76,000 lbs.
* See http://m-1rail.com/m-1-rail-announces-vendor-streetcar-build/ , http://m-1rail.com/faq/, and http://www.hntb.com/sites/default/files/HNTB_ITX_OffWireTech_914.pdf

On-board Energy Systems: Batteries
Additional Notes on Seattle Streetcar

* According to http://www.hntb.com/sites/default/files/HNTB_ITX_OffWireTech_914.pdf, "Seattle officials opted for off-wire technology on the First Hill Streetcar line to avoid conflicts with existing overhead trolley wires used by the city's electric bus system."
* Typical voltage of overhead wire systems is 750 volts DC. The Seattle project recommended a battery capable of at least 600 volts DC.
* Initially 3 segments totalling about 1 mile (20%) of the route were intended to be wireless, but it was determined that the entire, mostly downhill inbound 2.28-mile segment could be wireless.
* Vehicles are 100% low floor by placing the batteries on the roof.
* Unit price of the roughly 70-ft vehicles was $3.155 million each, only $90K more than the equivalent conventional streetcar by the same manufacturer (Inkeon of the Czech Republic).
* Porter, Denny and Ethan Melone, 2013, The New Seattle Streetcar with Onboard Energy Storage. In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 190-200. (http://trid.trb.org/view.aspx?id=1298696).
  - "Seattle DOT used a two step, best-value procurement process; however, defining basic OESS performance requirements was not as straightforward as in a procurement for conventional cars. Many new performance variables can come into play. Three solid proposals were received."
  - "The cost premium for OESS was originally estimated to be in the range of $500,000 per car, but the Seattle results indicate it may not be as significant as originally assumed."
* Tramways & Urban Transit, Seattle's Inkeon Battery Tram Arrives, 14 April 2015, http://www.tautonline.com/seattles-inekon-battery-tram-arrives/.

Wireless Technologies - Limitations

	Wayside power for full route	Higher capital costs	Lacks energy for 20 hours	Size & weight	Does not work under water	Longer station dwell times	Vehicle emissions	Slow charge times	Under-powered if used alone
Ground-Level									
In-ground contact rail	X	X			X				
Wireless induction	X	X							
On Board									
Super capacitors	X	X		X					
Flywheels	X	X		X		X			
HC Fuel tanks							X		
Batteries			X	X				X	
Fuel cells									X
Battery-Fuel Cell Hybrid									

53

Wireless Technologies - Limitations
Additional Notes

* The paper by Swanson (2013) does an excellent job of summarizing the advantages and disadvantages of each wireless technology: Swanson, John D. (Parsons Brinckerhoff), 2013. Practical Off-Wire Streetcar/Light Rail Operation . In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 181-189 (http://trid.trb.org/view.aspx?id=1298693).
* According to Swanson (2013), ground-level power systems "are overall typically 3 to 8 times as expensive as a traditional overhead catenary system (OCS) system, although recent studies by others have estimated these costs to be in the range of 1.5 to 2 times as expensive, not taking into account any additional civil work or utility relocation, etc." (p. 183).
* Super capacitors and flywheels also tend to be more expensive than on-board energy systems because they still require high-voltage power, transformers, and substations along most of the route because the super capacitors and flywheels have to be recharged at most stations. Off-wire distances using super capacitors "are typically limited to between 300 and 2,500 ft" (p. 186).
* Flywheels "typically require 40 seconds to recharge, twice as long as a normal maximum station dwell time" (p. 184).
* Flywheels, super capacitors , and batteries are all heavy and bulky.
* Hydrogen storage is bulky but lightweight, and can use virtually unlimited storage on roof of car.
* Batteries cannot hold enough energy for the entire route for 20 hours of operation plus HVAC, and they charge too slowly to be recharged during the day. High voltage fast charging degrades battery lifetime more rapidly. Batteries need cooling.
* Lithium titanate batteries have potential to charge in roughly 15 minutes at the terminal stations, and do not degrade as quickly as lithium ion or lithium iron phosphate (per Dale Hill, Proterra: http://www.proterra.com/).
* Cold-start effects play a significant role in power limitations in a fuel cell vehicle, and may require hybridization (batteries) to supplement available power at start-up.

A Commercially Available Self-Powered Technology Exists

Self-powered through hybridization of:

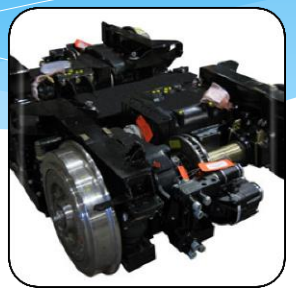
* Overnight battery charging (off-peak)
* Regenerative braking
* On-board hydrogen tanks and fuel cells

Combines technologies proven in:

* Automotive
* Rail
* Forklifts
* Remote locations
* Space program

Completely eliminates substations, transformers, high-voltage electricity, and overhead or underground wires for entire 3.1 mile route.

TIG/m On-Board Hybrid Propulsion System is Based on Proven Components



H_2 Tanks

H_2

Fuel Cells

Battery

Electric Motor and Wheels

H_2

H_2 Station

Regenerative Braking

Overnight

"Proof of Existence"
Additional Notes

* "Proof of existence" is an industry term for evidence that if an RFP is issued with certain specifications, at least one company will be able to meet the criteria and prepare a compliant bid. It does not preclude other vendors bidding on the same or different technologies that might also be able to satisfy the same specs.
* We studied the TIG/m technology in depth, including a conference call with CEO Brad Read, numerous emails, the www.tig-m.com/ website, a scientific paper (Schwartz, Sam and Brad Read, The Self-Powered Streetcar Revolution: The New Affordable Transit Option of Cities Worldwide, *Urban Public Transportation Systems, Nov.*, 2013, pp. 413-419: http://ascelibrary.org/doi/pdf/10.1061/9780784413210.037), and a rail industry report (Tramways & Urban Transit, Hydrogen: the Holy Grail for Off Wire Operation? 27 Jan, 2015, www.tautonline.com/hydrogen-holy-grail-wire-operation/).
* We determined that the TIG/m product is "proof of existence" of a completely self-powered wireless streetcar technology that can operate 20 hours per day over a 3.1 mile route in Tempe's climate. Because it requires no high-voltage power anywhere along the route, it can accomplish this while decreasing the capital costs of building the project.

"Self-Powered Hybrid"
Additional Notes

* The TIG/m self-powered streetcar uses three sources of on-board energy:
  * Overnight battery charging
  * Overnight filling of hydrogen tanks
  * Regenerative braking that returns some energy to the battery during the day
* This technology goes by several names:
  * Battery powered with hydrogen range extension. The traction power for moving the streetcar comes exclusively from the high-voltage battery. What the hydrogen fuel cells do is extend the driving range of the batteries to more hours and/or longer distance by continually recharging the batteries.
  * Self-powered streetcar. TIG/m likes to call their technology "self-powered" rather than "wireless" to emphasize the fact that it leaves the rail maintenance facility every morning with all the energy it needs for the entire 20-hour duty cycle. It thus requires no high-voltage power anywhere on the route. That's where the big capital cost savings come in. The combination of these three sources of energy make this possible.
  * Battery-fuel cell hybrid streetcar. The design of this technology is very similar to a plug-in hybrid Chevrolet Volt. The Volt is a series hybrid, in the sense that the forms of energy are in a single sequence or series, with a gasoline tank feeding fuel to an internal combustion engine, which runs an electrical generator, which charges the battery during operation. Drivers plug in the Volt overnight and stop at gas stations to fill the tank. GM trademarked the term "range anxiety" because of the clever way the Volt relieves the driver of worry that they will be stranded if their battery runs out. It uses hydrogen tanks and fuel cells to charge the battery. In contrast with the Volt, most other plug-in hybrid EVs, such as the Toyota Prius Plug-in or Ford's C-Max Energie or Fusion Energie, are "parallel" hybrids in the sense that both the internal combustion engine and the electric motor can drive the wheels directly at the same time ("in parallel"). All of these vehicles also incorporate regenerative braking to use braking energy to recharge the battery.

    Returning to the battery-fuel cell hybrid streetcar, it is essentially like a very large Chevy Volt that runs on rails. It is powered by batteries, but with hydrogen storage bottles replacing the gasoline tank, and the fuel cell replacing the internal combustion engine and electric generator, which keeps the battery charged.

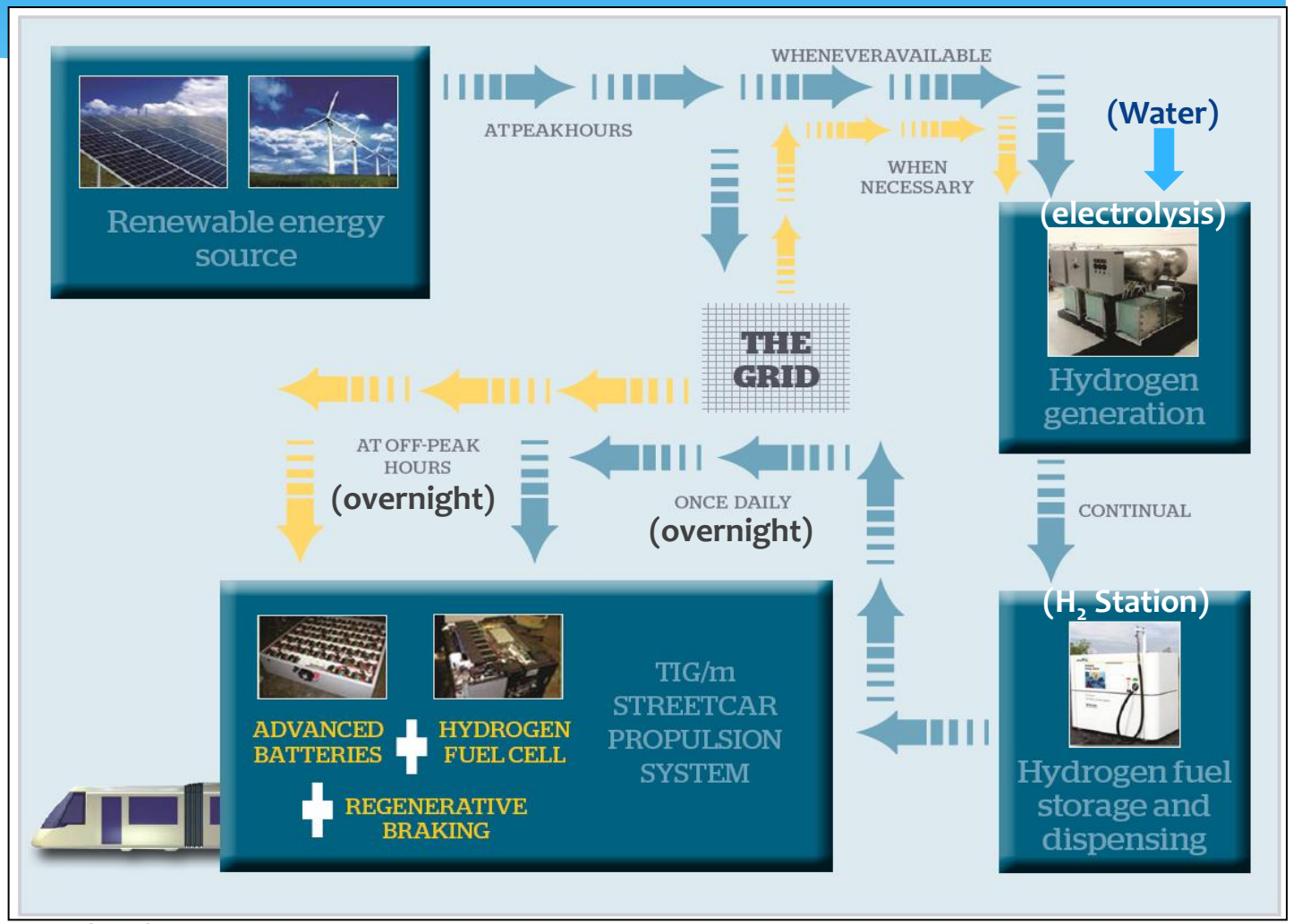
Off-Vehicle Supportive Energy Systems
Additional Notes

A battery-powered streetcar with hydrogen range extension requires supportive, off-vehicle energy systems. These are essential parts of the overall energy system, and would be located at the rail maintenance facility. They include:

* Battery Charging. The TIG/m streetcar uses lithium-iron-phosphate batteries that would be charged overnight with numerous 240-volt plugs. They can be charged at 110V, 240V, or 480V (DC), similar to what are known as Level 1, 2, and 3 charging for EVs. Charging at 110V, however, is too slow, while fast-charging at 480V reduces the lifetime of lithium-ion and lithium-iron-phosphate batteries. By having many 240V plugs where each one can charge its set of battery cells in a few hours, the lifetime of the battery is extended. 240V is similar to a typical household dryer or water heater power supply.
* Hydrogen Station. Unlike most fuels, it can be more economical to produce hydrogen at the station rather than deliver it to the station. Both models, however, are in use today. The two most common ways to generate hydrogen in commercial use today are steam-reforming of natural gas (CH_4) and electrolysis of water (H_2O). Steam reforming, however, uses fossil fuels and emits carbon dioxide. See http://www.afdc.energy.gov/fuels/hydrogen_production.html.
    * We recommend electrolysis, which uses electricity to split water into hydrogen and oxygen. Essentially, electrolysis is a fuel cell in reverse. We recommend it because there are no on-site carbon emissions, and it can use renewable electricity such as solar power. In addition, as grid power gets greener over time, the electrolysis process gets more sustainable.
    * After it is generated, the hydrogen is compressed and pumped into a storage tank.
    * The pressurized hydrogen and oxygen cartridges on the roof of the streetcar would be refilled each night. Locking air-tight mechanisms located on the side of the streetcar at ergonomic height allow a worker to easily refill the tanks from ground level.
* The battery-fuel cell hybrid streetcar can take maximum advantage of time of use electricity rate plans. Batteries can be charged overnight at the cheapest electricity rates. If equipped with solar panels, the hydrogen station can electrolyze water into hydrogen and oxygen during the day with little to no use of grid electricity. When the sun is down, the electrolyzer can use grid electricity at a cheaper rate.

The Full Energy System: On-board and at Maintenance Facility
Additional Notes

* Blue arrows = renewable electricity and hydrogen
* Yellow arrows = grid electricity



Source: Tramways and Urban Transit, January 2015

"Proven Components"
Additional Notes

* Individually, all of these technologies have been used for decades and are extremely well understood. In sequence:
  - At rail maintenance facility
    - Solar Photovoltaic Panels
    - Electrolyzer
    - H2 tank and pumps
  - On board Streetcar
    - H2 Storage in bottles
    - Fuel Cells
    - Lithium-iron-phosphate battery
    - Regenerative braking
* Plug-in hybrid automobiles have now been in use for several years, and sales are growing faster than pure electric vehicles.
* Numerous streetcar propulsion systems combine batteries and regenerative braking with other sources of supplemental energy.
* Battery range extension using hydrogen is catching on for automobiles, delivery vans, and buses:
  - http://www.autoblog.com/2015/01/26/symbio-returns-with-hydrogen-range-extender-kangoo-ev/
  - http://www.greencarreports.com/news/1089920_fedex-follows-french-lead-tests-hydrogen-fuel-cell-range-extenders
  - http://www.lotuscars.com/engineering/case-study-hydrogen-fuel-cell-taxi
  - http://evobsession.com/french-post-office-renault-trucks-introducing-ev-truck-hydrogen-powered-range-extender/
  - http://gas2.org/2015/01/15/solaris-electric-bus-also-packs-a-hydrogen-fuel-cell/
* TIG/m is a "system integrator" that uses equipment from established component manufacturers such as Plug Power for the fuel cells (see http://www.plugpower.com/GenDrive/Customers/WhosUsingGenDrive.aspx).

Smart Integration of Technologies

* Regenerative braking great for stop-and-go streetcar
* Fuel cell well suited for recharging battery—less challenging than for traction
* Battery warranty doubled by avoiding deep cycling
* Fuel-cell for range extension is well suited to rail
  - Rail has less rolling resistance than bus or automobile
  - Rail needs only one centralized hydrogen station

Smart Integration of Technologies
Additional Notes

* Streetcars operate on city streets with stop-and-go traffic. Much propulsion energy is wasted in the braking process. Without batteries, flywheels, or super capacitors to recapture the braking energy, the system will use more electricity than necessary, especially at peak electricity-rate times of day.
* The combination of batteries and fuel cells on a streetcar overcomes limitations of the individual technologies in several ways:
  - If a hydrogen fuel cell were to be the only source of traction power for a large streetcar, the fuel cell stack and hydrogen and oxygen storage capacity would need to be significantly larger and more expensive. The fuel cell stack would be called on to provide short, heavy surges of power. Batteries are much better suited to that. However, by using the fuel cells continuously to charge the batteries and run the HVAC units, the fuel cells can be significantly smaller. Thus, hydrogen fuel cells are much better suited to the task of battery range extension.
  - Similarly, if batteries are the sole source of power on a wireless streetcar, they would need to be fast-charged during the day (which is too slow and degrades battery life for most types of lithium batteries) or they would have to be much larger and be drawn down to low levels at the end of a long, hot day. L-ion or L- iron-phosphate battery life is reduced, however, by repeatedly deep-cycling down to a low state of charge. By combining lithium batteries with hydrogen range extension, the batteries can maintain a relatively high state of charge over the entire duty cycle, which enables TIG/m to double the battery warranty from 5 to 10 years.
  - That being said, with virtually unlimited room on the roof of the streetcars to store additional hydrogen, the fuel cells and storage bottles can be sized to provide as much power as necessary to extend the battery range and power the HVAC systems.
  - Like rail in general, streetcars are much more energy efficient than buses and cars. Steel wheels on steel rails exert 70% less rolling resistance than rubber tires on roads. In this sense, batteries with hydrogen range extension have less work to do than even for a bus of half the size.
  - Use of very high-efficiency HVAC units is an important additional element of this self-powered energy system.
  - Finally, unlike automobiles, streetcars travel a single route all day long. They do not require an extensive network of fuel stations all around the region. The main barrier holding back the introduction of hydrogen fuel cell cars in recent years has been the lack of fuel stations. Also, the hydrogen fuel stations for cars are more expensive because they need to generate and store larger amounts of hydrogen. For the streetcar, the generating and storage capacity is known in advance, and even overbuilding the station to provide a safety margin of excess hydrogen, the station will be much cheaper to build and only one station will be necessary.

Status of Other TIG/m Self-Powered Streetcar Projects
Additional Notes

* **The Grove (battery only, 0.4 miles):** Built in 2002, it uses 35-ft, open-air, heritage-style streetcar in a retail complex in Southern California. It does not use hydrogen for range extension. The batteries are charged overnight. The streetcar carries about 3 million passengers per year. http://www.railwaypreservation.com/vintagetrolley/los_angeles.htm
* **Aruba (battery powered with hydrogen range extension, 0.75 miles):** the 40-ft heritage-style open-air streetcars have been in service for over 3 years on a completely wireless route. Because Aruba has not completed the code compliance for the hydrogen generation station, they have been running on battery only for 10 hours per day and returning with 50% state of charge. www.altenergymag.com/news/2013/03/27/tigm-modern-street-railways-delivering-world39s-greenest-streetcars-to-aruba-in-island39s-transition-to-100-sustainability/28761 and http://www.tramz.com/aw/aw.html
* **Dubai (battery powered with hydrogen range extension, 4.2 miles):** the first car was delivered in February 2015 for testing and rigorous certification based on European standards. They are heritage-style, double-decker streetcars with air-conditioned lower level and open-air upper level with capacity for 74 passengers. The initial segment is 1 km long.
  * www.emirates247.com/news/emirates/dubai-trolley-arrives-in-downtown-set-to-roll-out-soon-2015-03-16-1.584363
  * www.railwaygazette.com/news/urban/single-view/view/hydrogen-fuelled-double-deck-tram-on-test.html?sword_list%5B%5D=fuel&sword_list%5B%5D=cells&no_cache=1
* **Qatar (battery powered with LPG range extension, 1.1 miles):** these are low-floor, 50-ft, modern streetcars. Qatar, an oil-rich nation, decided to use LPG (such as propane) for range extension.
* For more information on TIG/m, see:
  * Tramways & Urban Transit, Hydrogen: the Holy Grail for Off Wire Operation? 27 Jan, 2015, http://www.tautonline.com/hydrogen-holy-grail-wire-operation/.
  * Schwartz, Sam and Brad Read, The Self-Powered Streetcar Revolution: The New Affordable Transit Option of Cities Worldwide, *Urban Public Transportation Systems, Nov.*, 2013, pp. 413-419: http://ascelibrary.org/doi/pdf/10.1061/9780784413210.037.

Status of Other Hydrogen Rail Projects
Additional Notes

Herman-Hesse, Germany, Hydrogen Fuel Cell Regional Rail

* Scheduled to open in 2018, 40 regional trainsets have been ordered. "While the fuel cells will feature **proven technology** already deployed in the automotive sector, Alstom will provide the software, control and energy storage equipment."
  - Railway Gazette, Fuel Cells to Power Regional Trainsets, 24 Sept, 2014: www.railwaygazette.com/news/technology/single-view/view/fuel-cells-to-power-regional-trainsets.html.
  - Railway Gazette, Emissions-free Trains to Support Railway Reopening, 19 March 2015, www.railwaygazette.com/news/single-view/view/emission-free-trains-to-support-railway-reopening.html

CSR Sifang Co. in Qingdao, China

* CSR Sifang claims its tram can be refueled in three minutes and run for up to 100km (62 miles) at speeds of up to 70km/h (44mph), carry 380 passengers (60 seated), while storage bottles onboard the vehicle can take 1000kg of hydrogen.
  - Railway Gazette, China Unveils Hydrogen Fuel Cell Tram, 23 March, 2015: www.railwaygazette.com/news/news/asia/single-view/view/csr-unveils-hydrogen-fuel-cell-tram.html.
  - Tramways & Urban Transit, CSR Sifang unveils new hydrogen-powered tram, 14 April , 2015: www.tautonline.com/csr-sifang-unveils-new-hydrogen-powered-tram/.
  - International Hydrail Conference: http://hydrail.org/.

Asturias, Spain

* Built by Spanish company FEVE
  - www.railwaygazette.com/news/urban/single-view/view/hydrogen-fuel-cell-tram-unveiled.html.

Appears to Meet Valley Metro and FTA Specs

* Confirmed by Dec. 22, 2014 conference call with Valley Metro and TIG/m CEO
* Further confirmation in Mar. 8, 2015 conference call with ASU Group and TIG/m CEO
* 80% low-floor (heavy batteries under elevated driver's seat and rear seats)
* Buy American – TIG/m headquartered in Southern California
* Meets all European specs – generally tougher than US specs
* **Proof of Existence – If RFP is issued, <u>at least</u> one company will be able to meet the criteria and prepare a compliant bid**

Overhead Transmission Wires are Ugly But Also Expensive and Unnecessary

Element	Year of Expenditure $ TOTAL (Million)
Traction power - substations	$ 7.5
Traction power- catenary	$ 11.1
Total Electrical	**$ 18.6**

Source: Tempe Streetcar _SCC_Workbook_Rev_16_SMALL_STARTS_021315.PDF

Different Style TPSS

Overhead Transmission Wires are Ugly But Also Expensive and Unnecessary
Additional Notes

With a completely self-powered streetcar, without overhead or ground-level power or charging on the route, we can avoid the cost of the following along entire 3.1 mile route:

* High-voltage electricity
* Overhead wires
* Underground wires
* Substations
* Transformers

Overhead transmission wires are ugly but also expensive
Additional Notes

* Here are the relevant lines from the budget worksheet for the Tempe Streetcar project:

MAIN WORKSHEET-BUILD ALTERNATIVE (Rev.16, June, 2014)

Tempe Streetcar — Today's Date 12/23/14
Tempe, Arizona — Yr of Base Year $ 2014
Marina Heights to Dorsey — Yr of Revenue Ops 2018

	Quantity	Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)	Base Year Dollars Unit Cost (X000)	Base Year Dollars Percentage of Construction Cost	Base Year Dollars Percentage of Total Project Cost	YOE Dollars Total (X000)
50.03 Traction power supply: substations		6,246	625	6,871				7,486
50.04 Traction power distribution: catenary and third rail		9,256	926	10,182				11,093

* We have not included any costs of planning and maintaining electrical substations, overhead catenary system, and treework.
* Source: Tempe Streetcar _SCC_Workbook_Rev_16_SMALL_STARTS_021315.PDF

Capital Cost Tradeoffs (rough estimates)

Cost Savings	($ millions)	Cost Increases	($ millions)
Wayside power systems	- $18.5	Vehicles (Est $0.5 million more per vehicle x 6)	+ $3.0
		Hydrogen Station	+$1.25
		Battery Replacement x 7 (10/20 yrs)	+ $1.2
		Spare streetcar	+ $5.4
TOTAL SAVINGS	**- $18.5**	**TOTAL INCREASE**	**+ $10.85**

Net capital savings of roughly $7.65 million (helps to close funding gap) plus aesthetic and reputation benefits.

Capital Cost Tradeoffs
Additional Notes

* By building a completely self-powered wireless streetcar system such as the TIG/m battery-powered hybrid with fuel cell range extension, we think the Tempe Streetcar could be built for roughly $7 to 8 million less than currently budgeted.
* This is the net savings, based on:
  - decreased costs of $18.6 million by eliminating all wayside power
  - increased costs of $10.9 million for costlier vehicles, a spare streetcar, a hydrogen station, and battery replacement
* These savings can reduce the current funding gap for the local match, improving our chances of FTA funding.
* We are using YOE (Year of Expenditure) numbers, which refers to the year when money is spent, not current costs. This is the far-right column of the budget spreadsheet.

Details:

* On the positive side of the ledger, the cost of all wayside high-voltage (750 Volt) power on the route would be eliminated. This means no substations, transformers, overhead wires, poles to support the wires, etc. Even at the rail maintenance facility where the streetcars would be charged overnight, no special electrical systems are needed. The charging ports use the same voltage as a household dryer. Valley Metro estimates this cost at $18.6 million.
* Continued on next page.

Capital Cost Tradeoffs
Additional Notes, continued

* On the negative side of the ledger, there would be several kinds of new capital costs as well as other costs that would increase relative to building the traditional system with overhead wires.
* We conservatively estimate the battery-hydrogen hybrid vehicles to cost $500K more than conventional streetcars, which have been budgeted at $4.9 million (YOE). Multiplied by 6 vehicles adds $3 million to the wireless system cost.
  - In a conference call with Valley Metro, TIG/m gave rough ballpark estimate of $4 to 4.5 million including spare parts, while in a conference call with our committee, TIG/m said vehicle costs for each job are "custom" but they don't think it will be a problem delivering cars within Tempe's budget.
  - Seattle reported budgeting $500k more for battery-powered streetcars and getting bids that were only $90K - $400 higher.
  - Dallas's battery-powered 66-ft modern streetcars cost $4.5 million each.
  - While batteries, fuel cells, and tanks will be added to the cost of each vehicle, there are also savings from not needing a pantograph on top of the vehicle (the arm that connects to the overhead catenary wires).
* FTA requires spare vehicles for times when other vehicles are being maintained. The number of spares should be 10-20% of the total fleet. Valley Metro is planning to use regular Metro light rail vehicles as spares, saving this cost entirely. Light rail vehicles could not, however, be used as spares on a wireless route. We therefore include the cost of one spare streetcar at $5.4 million, which is $500K above the $4.9 million YOE estimate.
* TIG/m can provide a complete turnkey system, including a hydrogen station, which they estimated at $1 million. We add a 25% contingency and include $1.25 million for the hydrogen station. Note that this is still less than the cost of a public automotive hydrogen filling station, mainly because the tank and generating capacity are much smaller, and public access is not required.
* TIG/m would warranty batteries for 10 years. Valley Metro estimates a vehicle lifetime of 25 years. This means batteries would need to be replaced twice during the vehicle lifetime, at 10 and 20 years. TIG/m estimates the traction battery cost at $100K per vehicle. We think battery costs are likely to come down over time, while performance is likely to improve. Also, there is a market for repurposing large lithium batteries after they are no longer adequate for transportation purposes. Here, we include a contingency factor of 15% in light of these considerations, and estimate battery replacement for 7 vehicles at $115K. We discount these future costs at a conservative discount rate of 2% annually, as typically done in life-cycle financial budgeting exercises. This reduces the present value of the future battery replacement costs from $1.6 million to $1.2 million.

Cost Tradeoffs
Additional Notes, continued

Several factors are *not included* in these tradeoffs:

* We did not include the costs of solar power for the hydrogen station. While desirable, they are not absolutely necessary – the electrolyzer will need to also run on grid electricity. Also, we believe there is a strong chance for the solar panels for this project to be funded by grants.
* We did not include maintenance cost tradeoffs. Fuel cells and batteries have fewer moving parts than a pantograph system, and we have heard anecdotally of the high costs of maintaining overhead wires on the route and trees that can interfere with them.
* Training of transit staff and emergency service providers for dealing with hydrogen should be anticipated.
* We have not included operating costs tradeoffs here. This needs further detailed study, and is affected by a large number of variables, some of which we list here:
  * Fuel cells and electrolyzers have much higher efficiencies compared with internal combustion, but energy will still be lost in converting from electricity to hydrogen and back to electricity.
  * Solar power for generating hydrogen during the day will offset substantial electricity costs and losses associated with electrolysis.
  * Charging batteries overnight on a time-of-use plan will further offset electricity costs compared with using power from overhead wires during peak periods.
* Tempe, Phoenix, and Valley Metro may want to build a larger hydrogen station at the rail maintenance facility for future fuel cell buses and public use of pumps. Typically, many early hydrogen and CNG stations are built at fleet bases with unmanned pumps "outside the fence" for the general public to use with swipe-card access. If a larger station is desired for these purposes, we think the added cost could be funded by grants.

Additional Question:
Why not build the traditional wired OCS system and then remove it when wireless technologies are more mature?

A report by HDR, Inc. for Washington, DC studied this exact question in a section on the "Feasibility, including cost, of converting to non-aerial motive power where aerial wiring has been installed"

* They analyzed a 2.4 mile wireless segment of the H St. line (5 miles round trip).
* The report estimated the cost of removal, salvage, and demolition of the overhead catenary system and power substations at **$2 million**
* In addition, they estimated the loss of the initial investment in the OCS and substation at **$22 million**
* The total economic cost of installing and later removing the wires was estimated at $24 million.
* In addition, there would be the cost of retrofitting the streetcars to operate wirelessly on part of the route, or to buy new streetcars.
* See: HDR, Inc. Comprehensive Assessment on Streetcar Propulsion Technology. Prepared for Council of the District of Columbia and District Department of Transportation, 31 July 2014.
* **Conclusion:** converting a wired system to wireless after it is built would be very expensive.

Environmental Tradeoffs

Positive Impacts	No Impact	Negative Impacts
Lower grid energy use and carbon emissions (if solar power is used to generate hydrogen)	No emissions from vehicles for either option (except pure water vapor)	Greater grid energy use and carbon emissions (if grid electricity is used to generate hydrogen)
Reduced "visual pollution"	No change in equity across groups (same route, same populations served)	
Fewer tree trimming or removal – more shade		

Environmental Tradeoffs
Additional Notes

The environmental impact analyses are an important part of the federal evaluation and funding process. This consists of an ecological, health, and safety analysis as well as an environmental justice (equity) analysis.

* The good news is that the major parts of the environmental impacts would not change at all:
  - The vehicle emissions would be completely unaffected by changing the propulsion system. A traditional wired streetcar is a zero-emission vehicle, but so is a battery-hydrogen fuel cell hybrid vehicle, which emits only water vapor, which is not an EPA criteria pollutant.
  - The alignment would be completely unaffected by changing the propulsion system. The line would go through the same neighborhoods and would serve and impact the same socio-demographic groups.
* There would be some minor changes to the broader environmental impacts.
  - On the negative side, we explained earlier that some energy is lost converting electricity to hydrogen and back to electricity. This would result in more total electricity consumption.
  - However, on the positive side, some of the electricity for generating hydrogen could come from solar power. Whether solar power could offset the energy losses depends on how much solar capacity is installed, which would likely depend on grant funding. We think there is a good chance that these impacts would mostly offset each other.
* Other environmental benefits:
  - Improved visual aesthetics.
  - Less need for tree trimming and removal to prevent interference with overhead wires. The result would be more shade, which would promote walking and biking and reduce the urban heat island effect.

Safety Tradeoffs

Positive Impacts	Negative Impacts
Safer for firefighters – no ladder trucks near wires	Risk of hydrogen fire at H_2 station or vehicle
No downed live wires from storms or crashes	
No substation/transformer explosion risk	

Safety Risk Assessment

* Hydrogen is 14X lighter than air and stored above ceiling of streetcars – any release goes up
* Hydrogen station isolated at light-rail maintenance yard
* Hydrogen permitting standards: www.hydrogen.energy.gov/permitting/fueling_stations.cfm
* Tempe Firefighters and Valley Metro staff will need training in dealing with hydrogen

Safety Tradeoffs
Additional Notes

On the positive side of the ledger:

* In Tucson, firefighters were concerned about the wires 19 feet above street level interfering with firefighting and ladder trucks. Firefighters had to be trained in cutting the high-voltage power lines. Increased risk to firefighters and a delay in response times are a likely result of dealing with the high-voltage wires while fighting fires in multi-story buildings along the route. This can be avoided entirely by using a completely self-powered streetcar.: https://arizonadailyindependent.com/2013/10/04/tucson-modern-streetcar-creates-fire-safety-concerns/.
* High-voltage wires pose a safety hazard to citizens. Downed wires can occur by:
  - Crashes into poles or problems with pantographs. See for instance: www.sfgate.com/bayarea/article/3-hurt-as-Muni-trolley-knocks-down-live-wires-3608610.php and http://www.vancouversun.com/Woman+possibly+shocked+downed+trolley+wires+Vancouver/9028639/story.html
  - Trees and large branches being knocked down by monsoon storms, microbursts, or crashes. See: www.centerpointenergy.com/newsroom/stormcenter/7ee0f25efaaa4110VgnVCM10000001a10d0aRCRD/ and http://boston.cbslocal.com/2012/10/30/mbta-resumes-service-after-hurricane-sandy-shutdown/
* Electric substations and transformers are at risk of explosion and fire. Numerous examples can be found online by Googling for images of substation and explosion.

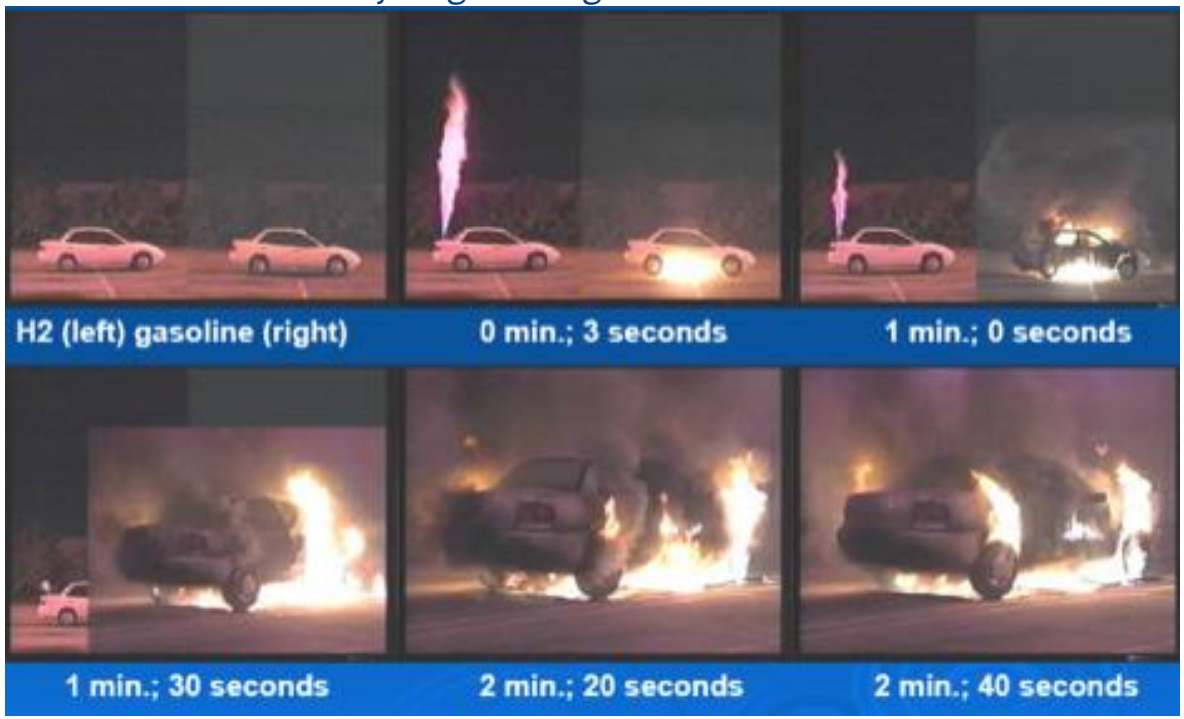
Safety Tradeoffs
Additional Notes

On the negative side of the ledger:

* Hydrogen is not necessarily less safe or more safe than more familiar fuels such as gasoline or electricity—it's just different and has some unique properties.
  - https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/doe_h2_safety.pdf
  - http://www.arhab.org/pdfs/h2_safety_fsheet.pdf
  - http://www.hydrogen.energy.gov/permitting/fueling_stations.cfm
* Hydrogen is an invisible, odorless, colorless, and tasteless gas that is flammable and explosive.
* Hydrogen is 14 times lighter than air, which means it rises and disperses very quickly. Storing hydrogen on the roof of the streetcar thus removes much of the risk hydrogen could pose to riders.
* With the hydrogen station at the rail maintenance facility, few people would be exposed to any risk, in contrast with the high-voltage wires on crowded pedestrian streets.
* It is very unlikely to cause asphyxiation because of how quickly it disperses.
* A hydrogen fire has significantly less radiant heat than a hydrocarbon fire.
* The US currently produces and safely uses more than 9 million tons of hydrogen each year.
* Hydrogen is not well known or understood by the general public. It may be associated in people's perceptions with a hydrogen bomb or the explosion of the Hindenburg zeppelin in the 1930s.
* Transit workers and emergency services will need training in dealing with hydrogen.

Safety Tradeoffs
Additional Notes

* Comparison of vehicle fire between hydrogen and gasoline vehicles



www.arhab.org/pdfs/h2_safety_fsheet.pdf

Partner with Center for Transportation and the Environment

* Since 1993, CTE has managed $290 million of clean, sustainable, innovative transportation and energy technology projects
* CTE can produce detailed modeling of energy and cost for specific route, location, vehicle, and rate structure, usually +/- 5% (contract cost would be $60K-$75K)
* CTE is trusted by FTA as honest, 3rd party evaluator of new technology
* CTE routinely works with FTA, DOT, DOE, DOD, NASA
* CTE has on staff engineers, economists, lobbyists, project managers
    - Project Planning
    - Grant Writing
    - Technical and Lifecycle Evaluation
    - Technical Specifications
    - Inspection
    - Deployment Oversight
    - Performance Monitoring
    - FTA Reporting

Center for Transportation and the Environment (CTE)
Additional Notes

* The Center for Transportation and the Environment, based in Atlanta, was highly recommended by Mr. Dale Hill, founder of Proterra, a South Carolina maker of fuel cell and electric buses. CTE helped get FTA funding for a number of their projects.
* Members of our study team had individual and group discussions with Dan Raudebaugh, Director of CTE.
* See attached document (CTE One Pager.pdf) for more information, or see http://www.cte.tv/.
* "CTE's mission is to improve the efficiency and sustainability of the United States' energy and transportation systems. As a member-based non-profit, non-governmental organization, [they] bring people together to advance clean, sustainable, innovative transportation and energy technologies."
* CTE's services include:
  - Project Planning & Initiation
  - Route Modeling & Analysis
  - Technical Specification
  - Technical Evaluation
  - Rate Modeling and Life Cycle Cost Analysis
  - Oversight/Inspection of the Bus Build
  - Deployment Oversight
  - Operational Data Collection
  - Key Performance Indicator Analysis & Reporting
  - Weekly Project Status Meeting & Coordination
  - Monthly Project Status Reporting
  - Quarterly FTA Status Report Preparation
  - Final report and project close-out
* One concern is their experience with FTA relates almost exclusively with buses. See next page.

Center for Transportation and the Environment (CTE)
Additional Notes

cte Center for Transportation and the Environment

About CTE | Current Projects | Membe

Current Projects

The following is a sample list of the more than 100 projects that CTE has successfully managed over the past 21 years.

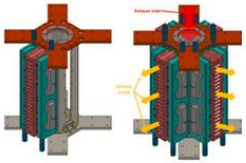
Lightweight Conformable Hydrogen Storage System

Public Hydrogen Fueling Stations

UPS Fuel Cell Hybrid Electric Delivery Van Demonstration

UTA Paratransit Reduced Idling System

Boston Electric Bus Deployment



Waste Heat Recovery at LYNX

Tompkins Consolidated Area Transit (TCAT) Fuel Cell Bus

AC Transit Fuel Cell Bus Fleet Extended Operations

Northern California Advanced Vehicle Technologies Program (NorthCAT)

Duluth Electric Bus Demonstration

Reduced Engine Idle Load (REIL) System

Lexington Electric Bus Deployment

Houston-Galveston Zero-Emission Delivery Vehicle Demo

CTTRANSIT Fuel Cell Bus Purchase

THE SOUTHEAST REGIONAL ALTERNATIVE FUELS MARKET INITIATIVES PROGRAM

Southeast Regional Alternative Fuels Market Initiatives Program

Center for Transportation and the Environment (CTE)
Additional Notes

* CTE is enthusiastic about working with Tempe and Valley Metro.
* They have offices in Atlanta and northern and southern California, with full-time lobbyists based in Washington DC and Sacramento.
* They have decades of experience working on fuel cells and battery buses.
* They have developed a strong working relationship with FTA as an honest, 3rd-party evaluator of technologies.
* They do advanced modeling of transit energy systems to make sure they will be successful in real-world applications. They validate their models with data from original equipment component manufacturers and based on post-implementation testing are usually within +/- 5% of actual usage.
* They would lose credibility with FTA and other federal agencies if their advance modeling were biased. Therefore, they are careful not to recommend technologies that are not ready or are not likely to succeed in the proposed application with its particular duty cycle, route, estimated loads, and climate.
* Recently, 4 out of 10 demonstration projects funded by FTA were managed by CTE.
* They think their participation would improve the chances of FTA approval of a fully self-powered and wireless streetcar Small Starts application, and they think there would be support for this within the FTA.
* CTE quickly put together a detailed proposed budget for modeling, simulation, and evaluation of wireless streetcar propulsion systems. The estimated budget comes to approximately $75k. They can reduce that cost to around $60k by excluding electricity rate modeling and the life cycle cost analysis.

Preliminary Risk Assessment and Mitigation

Risk	Mitigation
What if company goes out of business?	• A risk even for established companies • Purchase insurance to cover future maintenance
What if on-board systems don't generate enough power?	• Shouldn't happen – easily modeled by manufacturer and CTE • Require a performance guarantee in contracts • Could design with extra capacity at the station, tanks, fuel cells • Fuel cell buses have seen little to no degradation or maintenance over 9,000-15,000 hours • Mobile hydrogen delivery to vehicles en route is possible
What if streetcars cost more than estimated?	• Not an issue with a fixed-price contract
Few vendors and limited experience	• Vendors really want that first US customer • Several companies now implementing hydrogen fuel cells w/ or w/o batteries in a wide range of vehicles and stationary power • Hydrogen production with electrolyzers is not new and is growing

Preliminary Risk Assessment and Mitigation
Additional Notes

Going with a relatively new wireless propulsion technology would not be without added risks. Here we address some of the risks that are causing concerns, and what can be done to manage and mitigate those risks.

* We spoke with the former Chair of the Transportation Research Board Subcommittee on Self-Powered Rail Cars, who suggested that one of the largest risks is that a new company can go out of business. We note that United Streetcar, the company that built the streetcars for Tucson, has subsequently gone out of business, so this can happen with any propulsion technology. See http://www.washingtonpost.com/local/trafficandcommuting/us-effort-to-help-build-homegrown-streetcar-manufacturer-falls-short/2014/11/29/98c649b0-70b9-11e4-ad12-3734c461eab6_story.html. Insurance can be purchased to cover costs associated with a supplier going out of business.
* Concerns have been voiced that wireless streetcar using on-board energy storage systems are at risk of running out of power over the course of a long, busy, hot day such as around July 4 in Tempe. Our study committee thinks this is an easy risk to address and it is very unlikely to happen. Streetcar manufacturers have models to simulate worst-case energy usage scenarios, and can easily determine if the sizes of the batteries, fuel cells, storage tanks, hydrogen station, and HVAC units are adequate to maintain the interior temperature and battery state of charge for successful operation. CTE offers independent analysis. Performance guarantees can be written into the contracts. Extra capacity can be added to all components with some additional cost to provide an additional margin of error. In a worst case scenario, a mobile hydrogen delivery truck can be used to deliver additional energy.
* Some concerns have been expressed that the streetcars could end up costing more than budgeted. While this can be a risk for cost-plus construction contracts, it is not a problem for streetcar procurement. Vendors would bid on an RFP and a fixed-price contract will likely be awarded. The risk of any cost overrun falls on the winning vendor.
* An additional risk is that few vendors, or only one, with limited experience, will be able to bid on the project. This risk can be managed by careful preparation of the specifications for the project in an RFP, which can be framed in such a way that more than one company or technology can bid. The RFP does not have to specify a single technology, but rather the required conditions and performance of the vehicles. A paper by 2013 paper by Porter and Melone goes into detail on how Seattle developed the RFP specifications for their battery-wireless streetcar:
  * Porter, Denny and Ethan Melone, 2013, The New Seattle Streetcar with Onboard Energy Storage. In Transportation Research Circular E-C177: *Sustaining the Metropolis: LRT and Streetcars for Super Cities*, pp. 190-200. (http://trid.trb.org/view.aspx?id=1298696).

Potential Risks to Funding

Risk	Mitigation
FTA prefers proven technologies	• FTA doesn't exclude off-wire technologies • Individual component technologies all proven • Integration of technologies also proven, just not on a streetcar in revenue service • FTA trusts CTE as honest 3rd-party broker • CTE managed 4 of 10 projects recently funded by FTA
FTA prefers US testing	• "Laws of physics are the same everywhere"
FTA funding contingent on local match	• By reducing capital costs by $7 to 8 million, FTA funding prospects will improve substantially
Changing propulsion now might delay FTA application	• Propulsion system does not have to be specified at this time • Environmental clearances can be modified • RFP could be broad enough for multiple bids (e.g., Seattle specified battery and/or super capacitor—but better to specify required attributes and not specify the technology) • Tempe would need representation on review committee to choose best bid
Delay may allow other Valley cities to leapfrog Tempe	• This is a political question beyond the scope of our study

87

Potential Risks to Funding
Additional Notes

A second set of risks revolve around not getting or delaying FTA Small Starts funding or delaying regional funding from Proposition 400 monies.

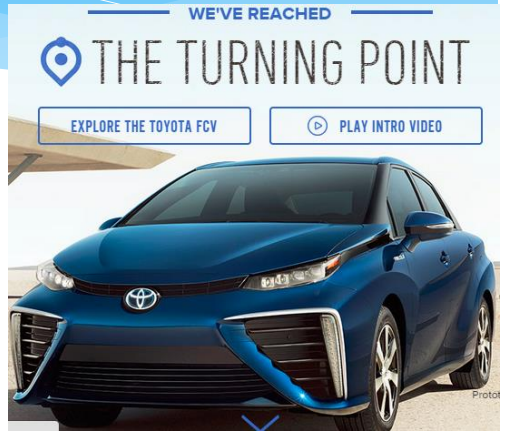
* FTA's policy on funding new technologies is not well understood. Clearly, they want to be confident that public monies are well spent on technologies that will perform as expected. However, FTA does not exclude off-wire technologies, as evidenced by the FTA funding of the Dallas streetcar project. It is not clear where exactly is the threshold for a technology to be considered "proven" enough for FTA funding. Certainly, all of the individual technologies in a battery-fuel cell range-extended hybrid streetcar are proven and well understood. Integration of these technologies is also proven, though not yet for a streetcar in revenue service. Dubai is testing the battery-fuel cell hybrid streetcars currently, and results may be available later in 2015. Independent modeling of this and alternative wireless technologies by CTE could increase confidence in the technology within FTA.
* Some concerns have been expressed that FTA requires new technologies to be proven in the United States. Several experts this committee has spoken with have disagreed with that, and clearly if that were the case, no new technologies would ever be tried in US transit systems unless done for the first time without any FTA funding, which is clearly not the case. Experts have said that "the laws of physics are the same everywhere," and that FTA does consider technologies proven outside the US.
* Certainly, FTA funding is contingent on Tempe closing the local funding gap. By eliminating the wayside high-voltage power requirements, Tempe can reduce up-front costs by $18 million. Added costs of about $10 million for a hydrogen station, vehicles including an additional spare, and replacement batteries bring the net savings down to about $7-8 million. This could make a significant contribution toward closing the estimated $23 million funding gap, which as it currently stands would eliminate any chance of FTA funding.
* Concerns have been expressed that it could be too late to modify the propulsion technology at this stage, with plans to submit the FTA Small Starts funding application in September 2015. However, TRB experts suggested that FTA would allow the proposal and environmental documents to be modified after approval, especially if it did not increase the costs or change the route, and that it is too soon to worry about specifying the propulsion system before the project gets FTA approval. As described earlier, after FTA approval, an RFP could be crafted with clear but broad specifications that would allow multiple vendors of different technologies to bid on the Tempe Streetcar project. Seattle's wireless streetcar RFP specified either of two technologies—batteries or super capacitors—but it would be better to specify the required attributes of the performance and not specify the technology.
* TRB experts emphasized that FTA should be viewed as partners more than judges, and it is important for Tempe and Valley Metro to engage in discussions with FTA to assess these issues.

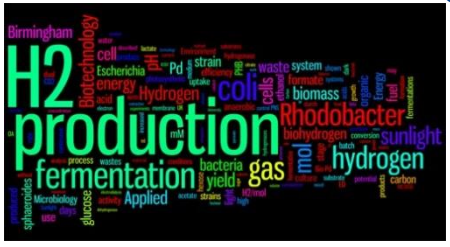
Intangible Benefits

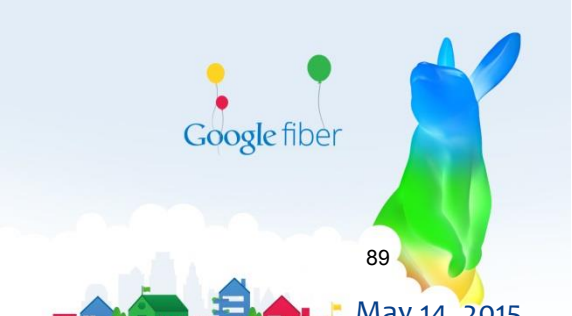
California Hydrogen Business Council

Connecticut Hydrogen-Fuel Cell Coalition

* Striking aesthetics
* Faster construction/less disruptive to business
* International reputation for innovation
* Study tours from other cities
* High-tech start-up companies
* Jumpstart on the hydrogen economy
* Valley Metro already a national leader in alt fuels
* Solar-hydrogen partnerships with ASU, APS, SRP, First Solar
* Removable streetcar windows (TIG/m)







Conclusions

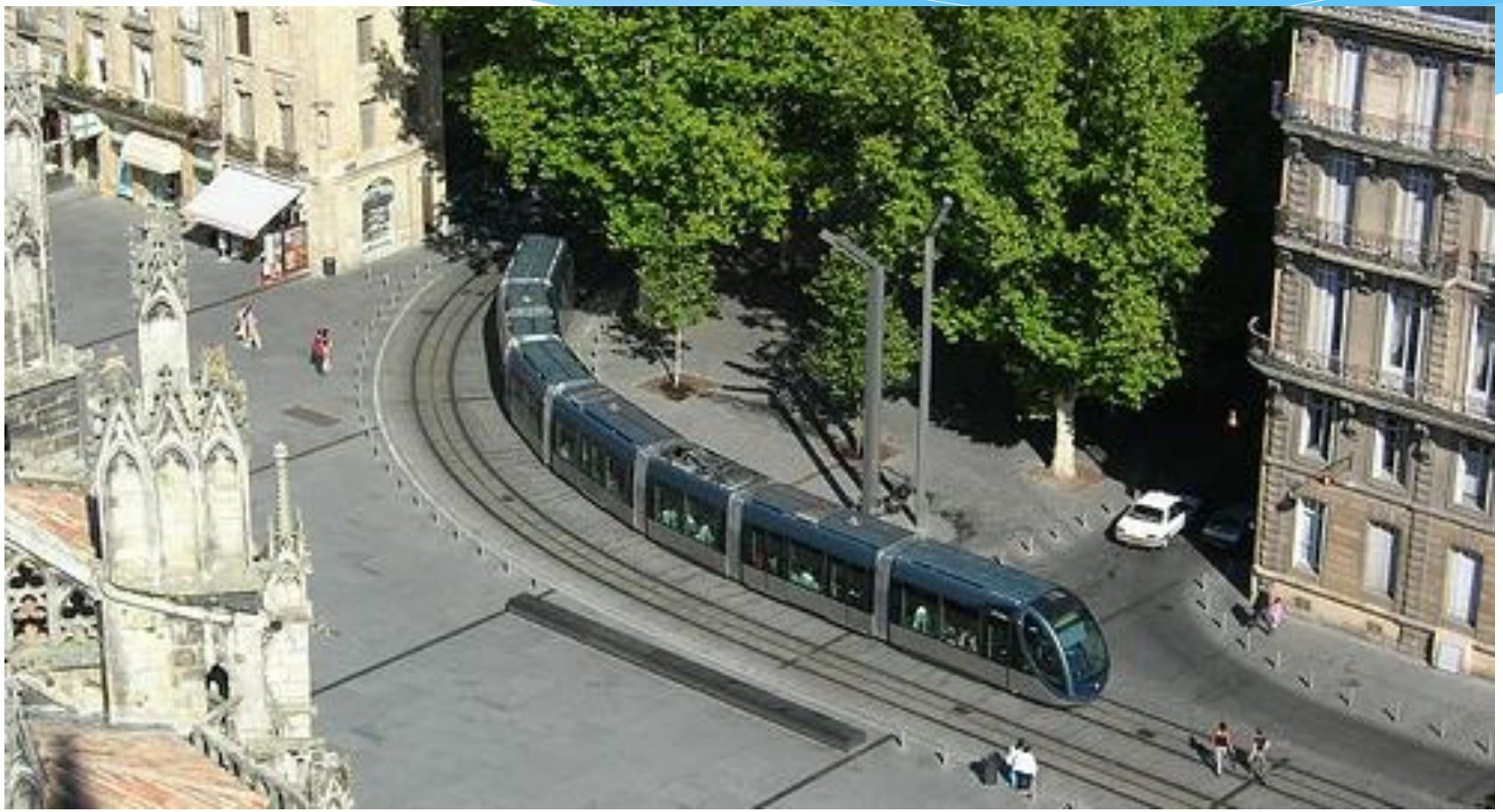
* Proof of existence that at least one **"win-win"** self-powered streetcar technology is commercially available and**:**
  - More attractive and more exciting
  - Suitable for Tempe route, hours, and climate
  - Net capital cost **savings** in neighborhood of $7 to 8 million
  - Safer and more sustainable
  - Integration of proven technologies
* There are ways to manage technological, perception, and financial risks through partnering with CTE, open RFP, careful contracting, insurance, additional performance margins, and contingency planning
* Reducing the funding gap improves chance of FTA funding

90

Recommendations

* Work with Valley Metro to continue advancing a proposal for FTA funding while keeping propulsion options open.
* Budget $60 to 75K for CTE to do cost and energy modeling of battery/fuel cell hybrid system and other wireless streetcar technologies for Tempe route and climate.
* With CTE's 3rd-party analysis in hand, partner with CTE and Valley Metro to engage with FTA and build FTA support.
* Begin developing appropriate RFP specifications and performance guarantees that would allow multiple vendors to propose competing technologies for a completely self-powered (or with extensive wireless segments) streetcar system with no high-voltage power requirements that would reduce capital costs, assess and mitigate risks, and help close the funding gap.

Questions?



Appendix 1
ASU Study Group Members

Dr. Ellen Stechel

Dr. Ellen Stechel is a Professor of Practice in Chemistry and Biochemistry at ASU, and Deputy Director of LightWorks. Prior to coming to ASU, she managed research departments in solar and emerging energy technologies at Sandia National Laboratories and before that at Ford Motor Company managing Chemistry and Environmental Science in the Scientific Research Laboratory and proving/deploying new low-emissions technologies in Ford Product Development, which included Ford's hybrid vehicle.

Dr. Stechel earned her PhD in Chemical Physics from University of Chicago.

Dr. Michael Kuby

Dr. Michael Kuby is Professor in Geographical Sciences and Urban Planning at ASU, and Director of the Interdisciplinary Graduate Certificate Program in Transportation Systems. He specializes in alternative-fuels vehicles and infrastructure and light-rail ridership. He has co-edited the last two Background Reports on Transportation for the Arizona Town Hall. He is Location Area Editor for the journal *Networks and Spatial Economics* and on the editorial boards for *International Regional Science Review* and *Journal of Transport Geography.*

Dr. Kuby earned his PhD in Geography from Boston University.

Dr. Mikhail Chester

Dr. Mikhail Chester is an Assistant Professor in Civil, Environmental, and Sustainable Engineering at ASU, where he runs a research laboratory focused on transportation life cycle assessment and infrastructure resilience to climate change. Dr. Chester has worked with a variety of public and private passenger and freight agencies to develop energy and environmental assessments of transportation systems including infrastructure, vehicle, and energy production processes, in addition to vehicle operation.

Dr. Chester earned his PhD in Civil and Environmental Engineering from UC Berkeley.

Appendix 2
Experts Consulted by Study Group

* Dr. Aaron Golub, Associate Professor, School of Geographical Sciences and Urban Planning, ASU
* Dale Hill, Founder, Proterra (electric and fuel cell bus company), Greenville, SC
* Jason Hanlin, Director of Technology Development, Center for Transportation and the Environment, Atlanta, GA
* Monica Meade, Parsons Brinckerhoff, Baltimore, MD and Chair, Streetcar Subcommittee, Transportation Research Board
* Brian Nadolny, Charlotte Area Transit System, Charlotte, NC
* David O. Nelson, Director of Transit Planning, Jacobs Engineering Group, Boston, MA and former Chair, Self-Powered Rail Car Subcommittee, Transportation Research Board
* Dr. Nathan Parker, Assistant Research Professor, School of Geographical Sciences and Urban Planning, ASU
* Dan Raudebaugh, CEO, Center for Transportation and the Environment, Atlanta, GA
* Brad Read, President, TIG/m Modern Street Railways, LLC, Chatsworth, CA
* Stan Thompson, Founder, International Hydrail Conference, Charlotte, NC

CITY OF TEMPE
TRANSPORTATION COMMISSION

STAFF REPORT

AGENDA ITEM 4

DATE
May 12, 2015

SUBJECT
Bike Bait Program

PURPOSE
The purpose of this memo is to provide the Commission with an update on the City of Tempe's bike bait program.

BACKGROUND
The Police Department will provide an update on the bike bait program. Included will be information and discussion on the efforts to reduce bike thefts since 2013.

FISCAL IMPACT
N/A

RECOMMENDATION
This item is for information only.

CONTACT
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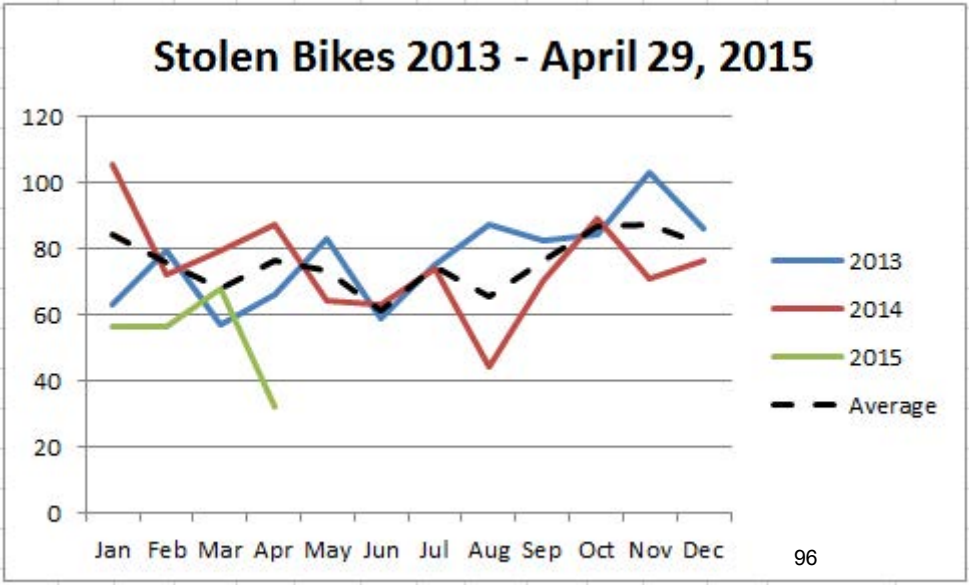
noah_johnson@tempe.gov

ATTACHMENTS


Stolen Bikes 2013 - April 29, 2015
120
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2013
2014
2015
Average

CITY OF TEMPE
TRANSPORTATION COMMISSION

STAFF REPORT

AGENDA ITEM 5

DATE
May 12, 2015

SUBJECT
Orbit Fleet

PURPOSE
The purpose of this memo is to provide the Commission with an update of the ongoing exploration of using larger vehicles for Orbit service.

BACKGROUND
The purpose of this memo is to provide the City Council with an update of the ongoing exploration of using larger vehicles for Orbit service.

Orbit neighborhood circulators were implemented in 2007 and 2008. Ridership performance on the five Orbit routes has been excellent and on occasion causing passenger overloads and boarding denials due to lack of vehicle capacity.

Table 1: Orbit Ridership by Route Since Inception in 2008

Calendar Year	Mercury	Venus	Earth	Mars	Jupiter	TOTAL
2008	697,498	790,928	356,638	173,813	644,931	**2,663,808**
2009	744,480	501,526	622,913	220,253	894,698	**2,983,870**
2010	722,354	515,743	472,575	525,584	482,743	**2,718,999**
2011	790,147	562,236	512,308	600,682	536,552	**3,001,925**
2012	722,573	524,411	544,161	568,909	509,193	**2,869,247**
2013	697,077	477,425	518,515	524,604	515,015	**2,732,636**
2014	619,128	441,597	395,565	412,342	477,784	**2,346,416**
	4,993,257	**3,813,866**	**3,422,675**	**3,026,187**	**4,060,916**	**19,316,901**

The vehicles currently used on Orbit are 24 feet long, have 17 seats and can accommodate up to 6 standing passengers. The number of passengers is limited by the Gross Vehicle Weight Rating of the vehicle and is often insufficient for our peak needs. In addition to the capacity

constraints, we have found that the current vehicle type used is not as robust as is required for our service scenario, leading to excessive wear, limited lifespan, and high maintenance costs.

Staff has implemented several solutions to address overcrowding, including increasing route frequency on Mercury and adding extra buses to Jupiter during peak times. These service augmentations, while costly, are necessary in order to provide the best service to our community.

Staff has long recognized the need for a larger and heavier duty vehicle for Orbit. Our concerns for neighborhood compatibility, as well as the lack of suitable vehicles on the market, have led us to continue purchasing the current vehicle type. In 2013, Tempe was asked by a manufacturer to test a 30' New Flyer MiDi medium duty bus on Orbit routes. In addition to the manufacturer's desire for a real-world test, this program allowed the City to gather community feedback to determine if a larger vehicle was acceptable to Orbit passengers and local residents.

The community was notified of the vehicle testing program and invited to submit comments. Feedback forms were available on board as well as on our website. After several months of testing the bus on each of the Orbit routes and one community meeting, we received 289 survey responses. The responses were overwhelmingly positive, as follows:

- 83% of respondents indicated that they lived along an Orbit route
- Respondents were divided among all five Orbit routes
- 95% of respondents reported that they are Orbit riders
- Over 85% indicated that more seating and space was important to them
- Over 85% indicated that their overall experience was better on the test bus
- Over 78% of respondents stated that the noise levels were the same or less than the current buses
- 81% reported that the presence of the test bus driving in their neighborhood was the same or better than the current buses
- 82% indicated that the test bus (compared to the current bus) has a positive impact on the community

Based on the positive survey results, along with the need to address capacity and reliability concerns, staff recommends moving forward with the addition of larger, heavy duty buses for Orbit service. If approved, larger buses would be introduced starting in 2016-17 and would gradually make up about half of the Orbit fleet. Some routes do not have ridership that would require larger buses, so the fleet makeup will include both the current size and the larger vehicles. Fleet composition will be continually evaluated and adjustments will be made based on ridership moving forward. It is a fleet best practice to ensure that fleet composition based on age and vehicle type is staggered and diversified to plan for service reliability and take advantage of emerging technology while managing risk.

In addition to the current capacity issues, community input for the south Tempe Orbit development has indicated a strong preference to travel to the Tempe Library/Pyle Center

complex. Should this occur, there is a strong possibility that people will transfer from the new Orbit route to Jupiter, which could lead to frequent overcrowding on Jupiter. The larger buses will help to mitigate this concern.

The MiDi test bus was a medium duty, 10-year diesel bus. There are currently no buses in the 10-year category available with a natural gas propulsion system. Because of the economic and environmental benefits of alternatively-fueled vehicles, we plan to procure 12-year heavy duty Compressed Natural Gas (CNG) buses that are approximately the same size as the test bus. Similar vehicles were recently procured by the City of Phoenix at a cost of approximately $506,000 per bus for 2016-17 deliveries. The most recently purchased Orbit cutaway buses, which have a 4-year average lifespan, cost $131,000 each. Adjusting that price for inflation, and considering that three cutaway buses would need to be purchased during the life of one 12-year heavy duty bus, the cost of the heavy duty bus is about $4,425 greater than the Orbit cutaway. Below you will see a comparison of the current Orbit vehicle and a representation of a 30' heavy duty vehicle.

Specifications	*Orbit Cutaway*	*Heavy Duty*
		
Length	24.5 feet	30 feet
Width	99 inches	102 inches
Height	128 inches	112 inches
Seats	17	24
Standing Capacity	6 passenges	26 passengers
Wheelchair Accomodations	Two wheelchair positions/vertical lift	Two wheelchair positions/extending ramp
Entry	Single door, high floor, step entry	Two doors, low floor with kneeling funtion
Bike Racks	Two bike positions	Two bike positions

While the acquisition cost of a heavy duty bus is marginally higher than the cutaway style bus currently used for Orbit, the increased reliability, improved passenger capacity, and lower maintenance costs, staff believes that the added expense is justified.

It should be noted that these vehicles will be competitively procured, and that each manufacturer's vehicle has different characteristics. Our specifications will state our preference for neighborhood compatibility and will limit the size of the vehicle to ensure that it is similar to the size that was tested. It is anticipated that the procurement will be led by the Regional Public Transportation Authority with Tempe as a partner.

FISCAL IMPACT

Staff estimates that the lifecycle acquisition cost of larger heavy duty buses would be about $4,425 more per unit than the light duty buses used for Orbit service today. Our Orbit fleet plan assumes that 25 of the larger buses will be included in the fleet, along with 21 cutaway buses. The added cost of the 25 larger buses would be approximately $110,625 over the 12 year lifespan of the vehicles. Because the vehicles will be competitively procured, the exact cost will be based on final pricing received from vendors. Based on our estimate of cost, it is expected that bus purchases will be funded with a combination of federal and regional Proposition 400 funds.

Vehicle Type	FY17	FY21	FY25	Total
Cutaway [1]	$147,961	$166,532	$187,433	$501,926
Heavy Duty [2]	$506,351			$506,351

Note 1: Cost estimate based on Tempe's most recent cutaway purchase in FY 2013, adjusted for 3% annual inflation.
Note 2: Cost based on Phoenix bid price for 30' CNG bus on current contract.

RECOMMENDATION

This item is for information and input.

CONTACT

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Senior Planner
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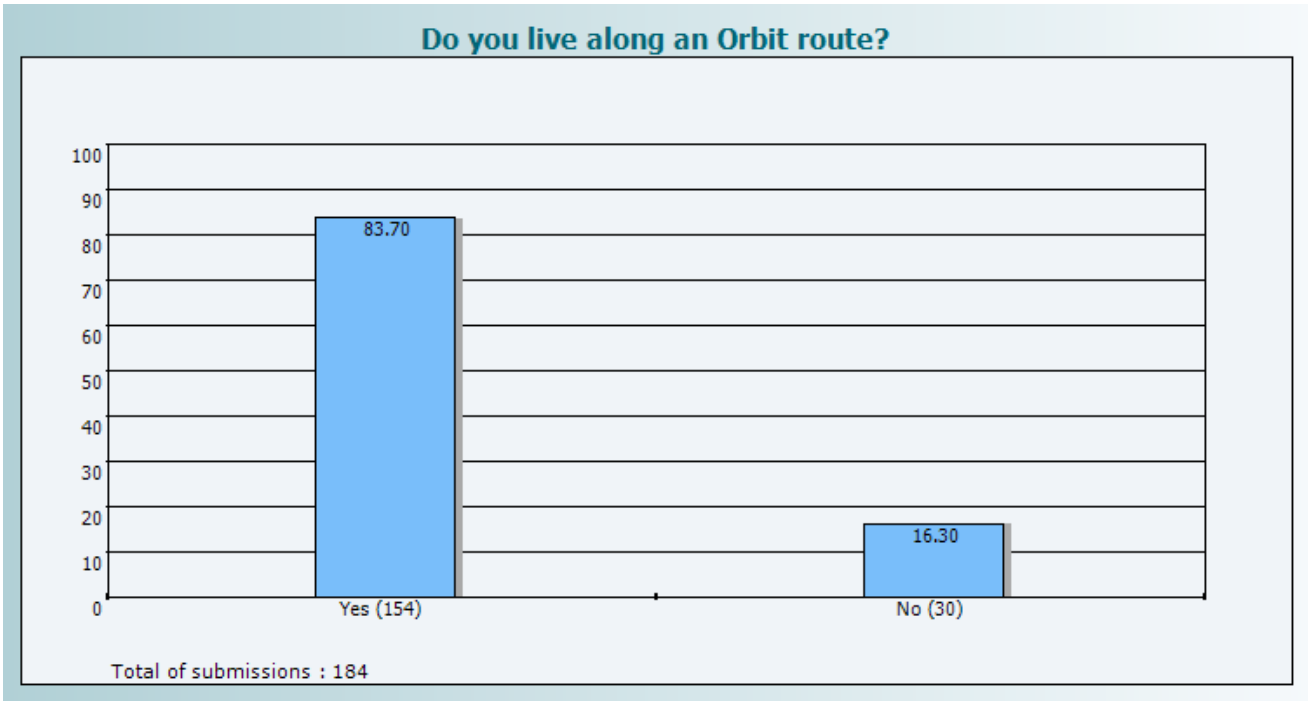
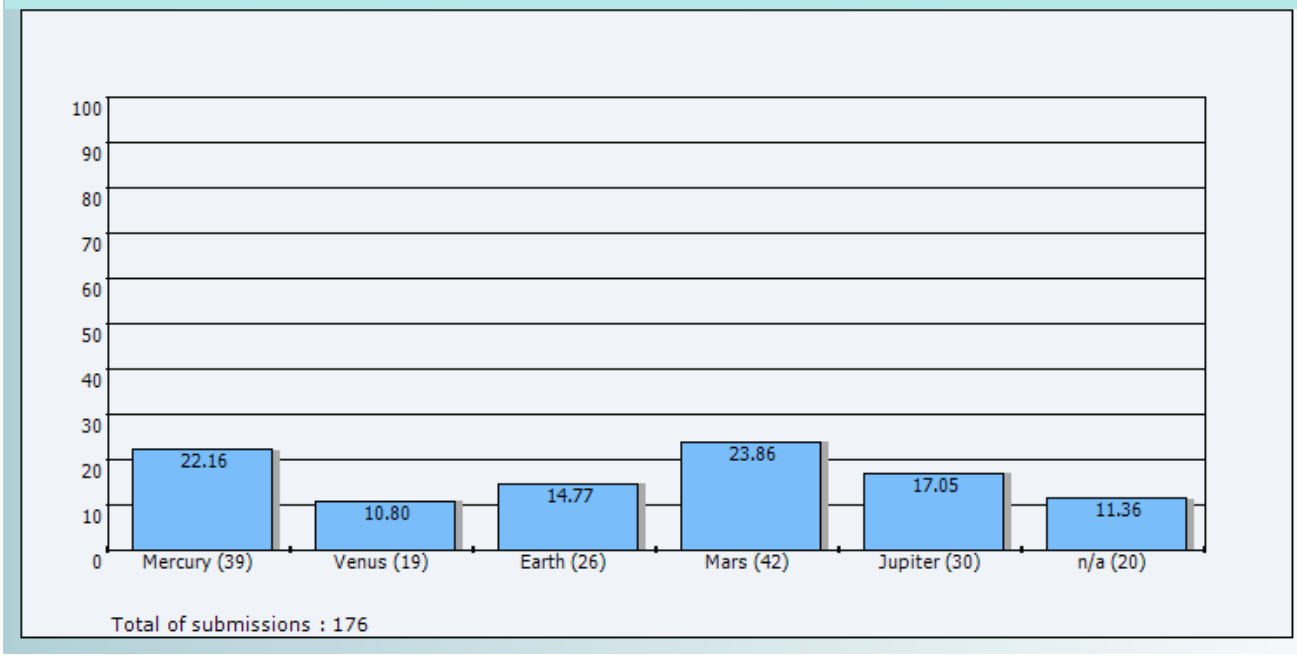
jason_hartong@tempe.gov

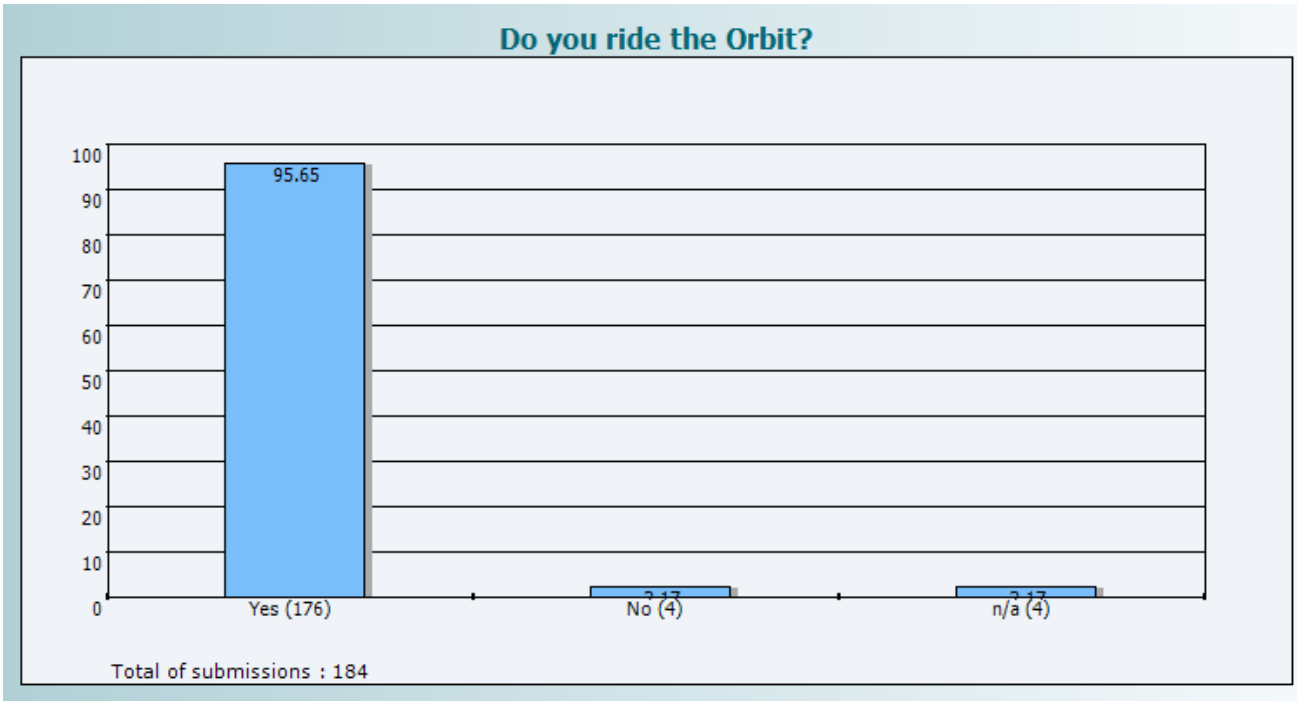
ATTACHMENT

Survey Responses
PowerPoint

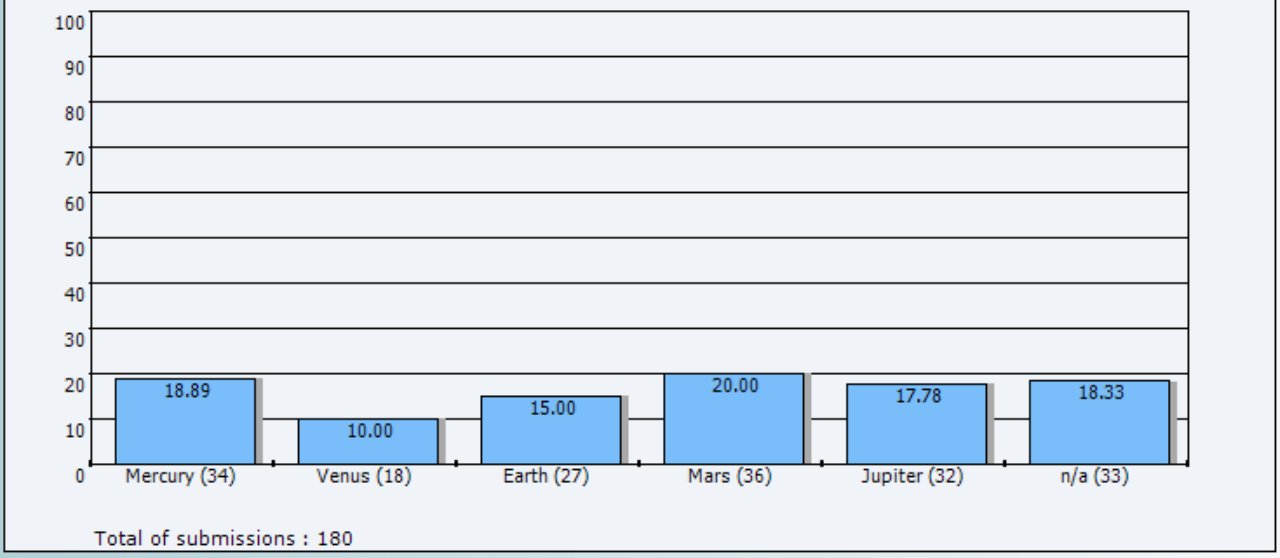

Do you live along an Orbit route?
100
90
80
70
60
50
40
30
20
10
0
83.70
16.30
Yes (154)
No (30)
Total of submissions : 184

If yes, which route?

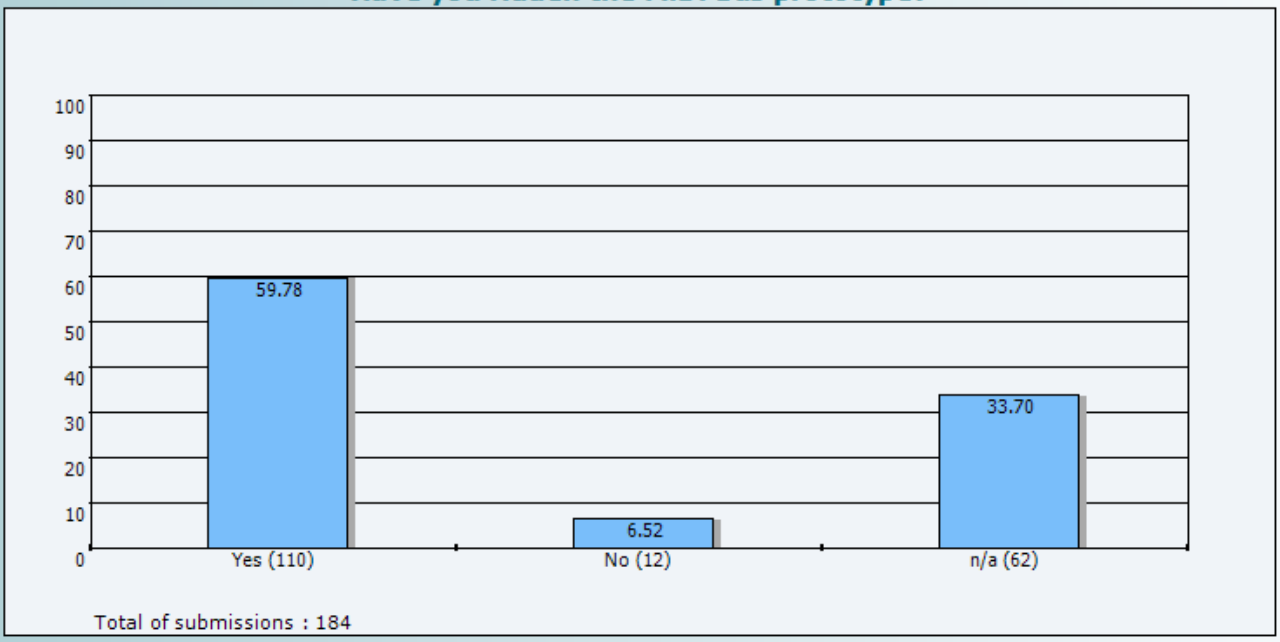




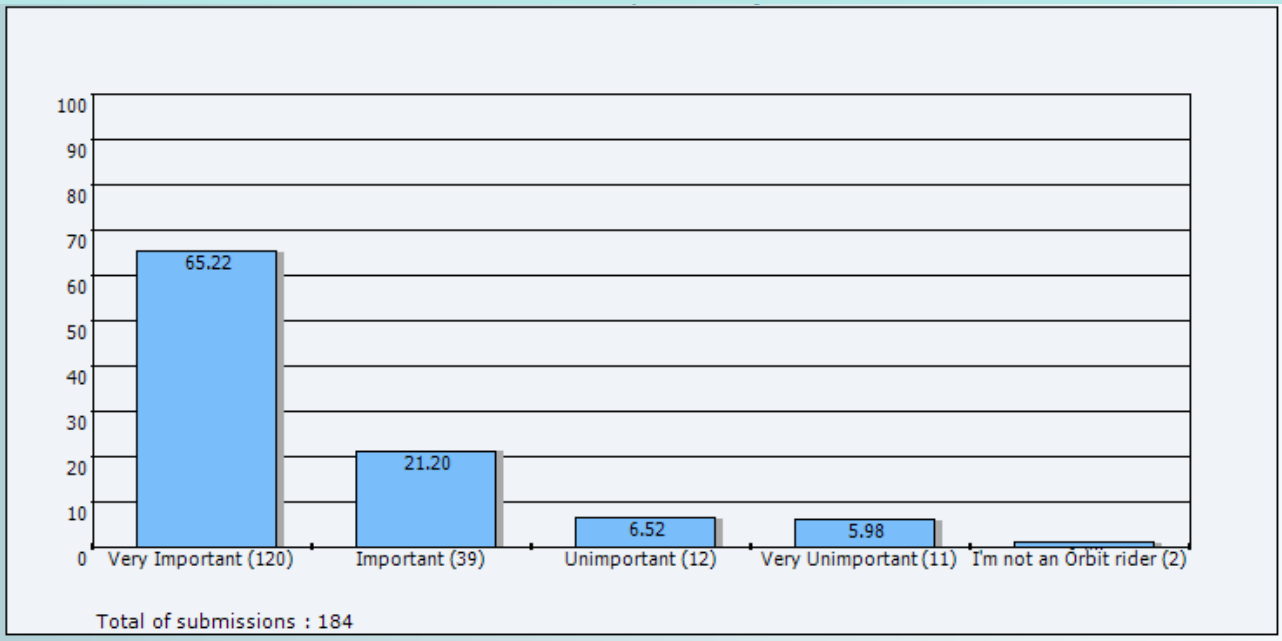
Which route do you ride most often?



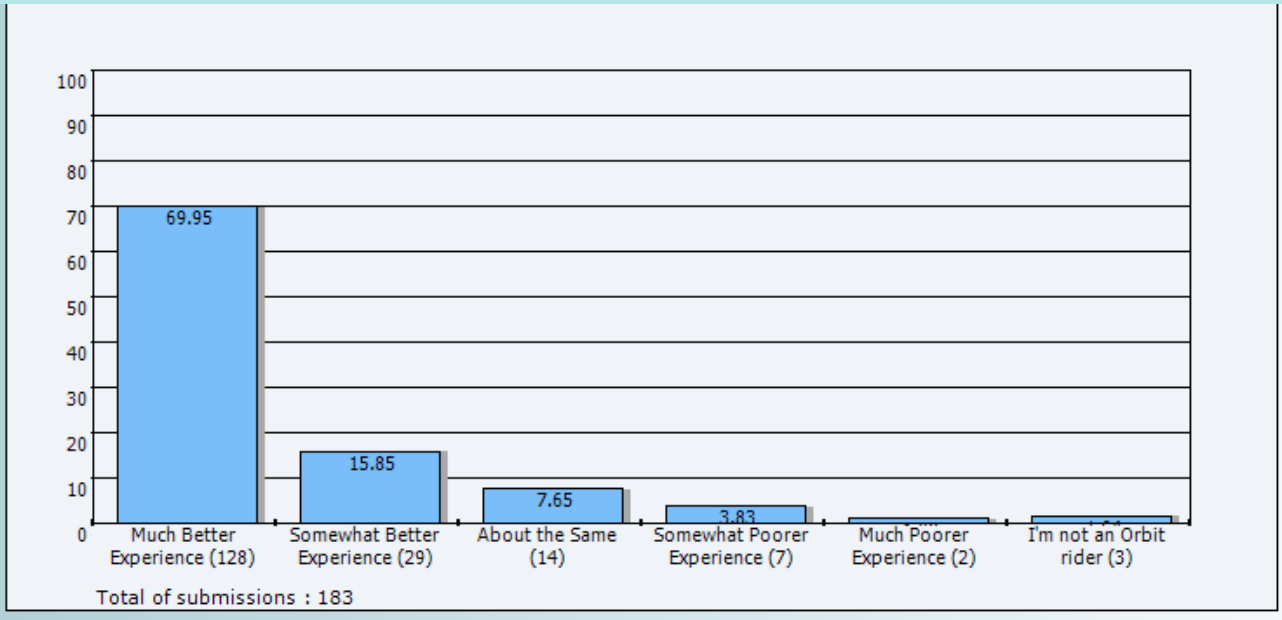
Have you ridden the MiDi bus prototype?



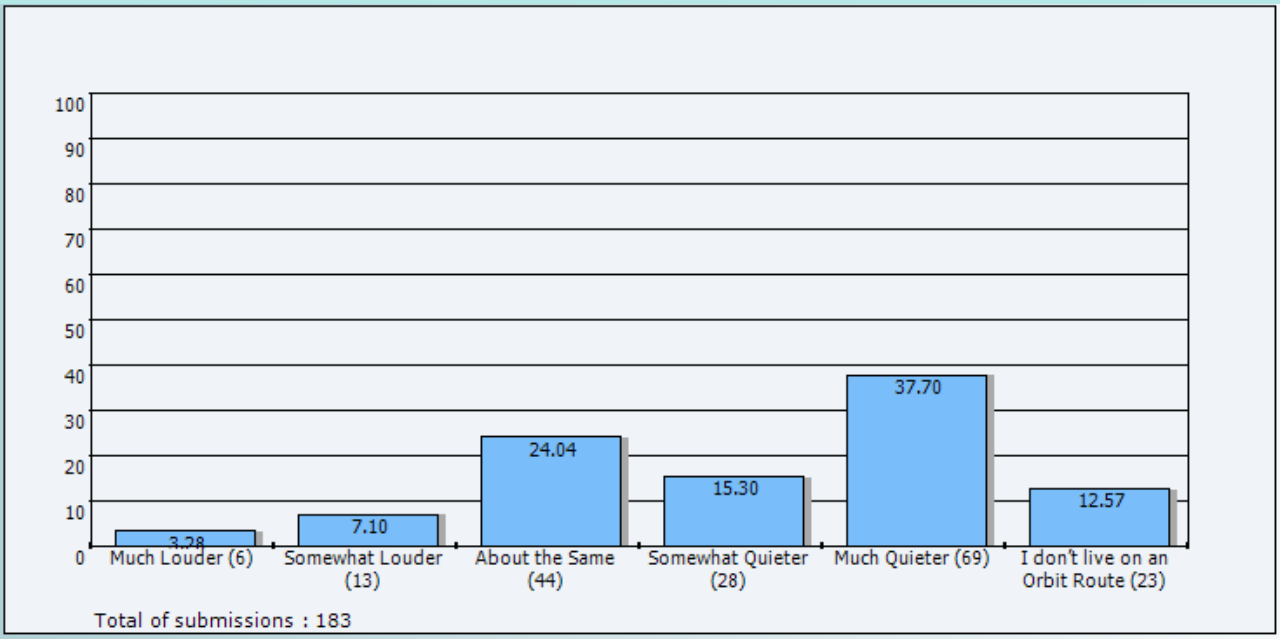
As an Orbit bus user, how important is it to add seating and space on the Orbit buses?



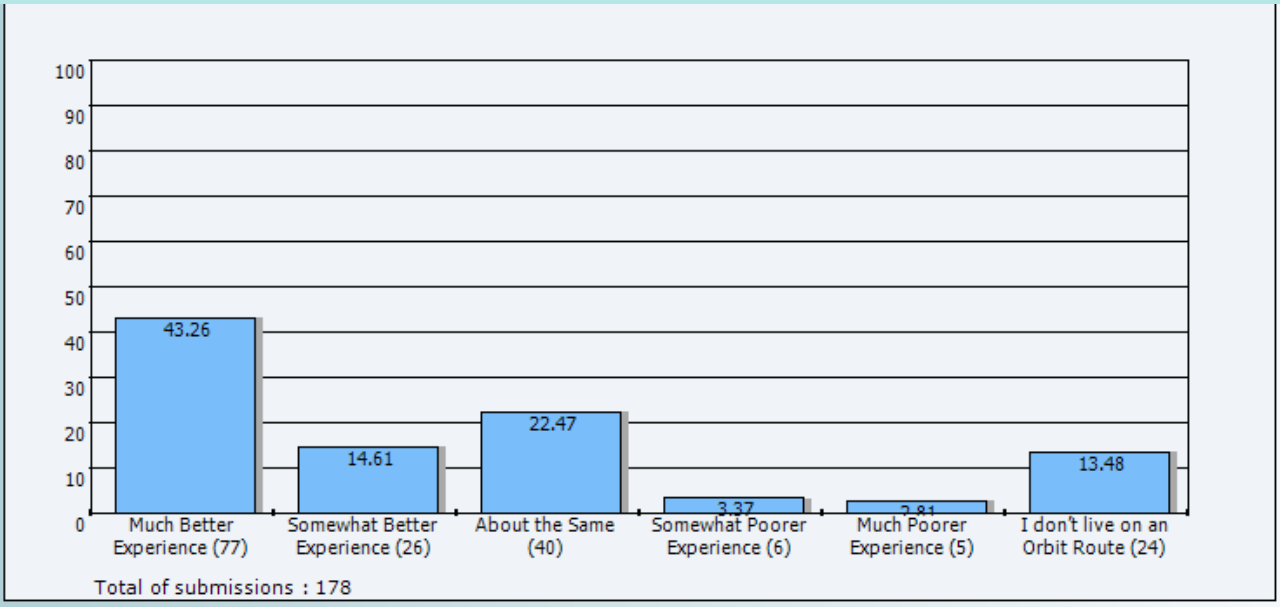
As an Orbit bus user, please indicate your overall experience as a passenger riding the test bus compared to the current buses:



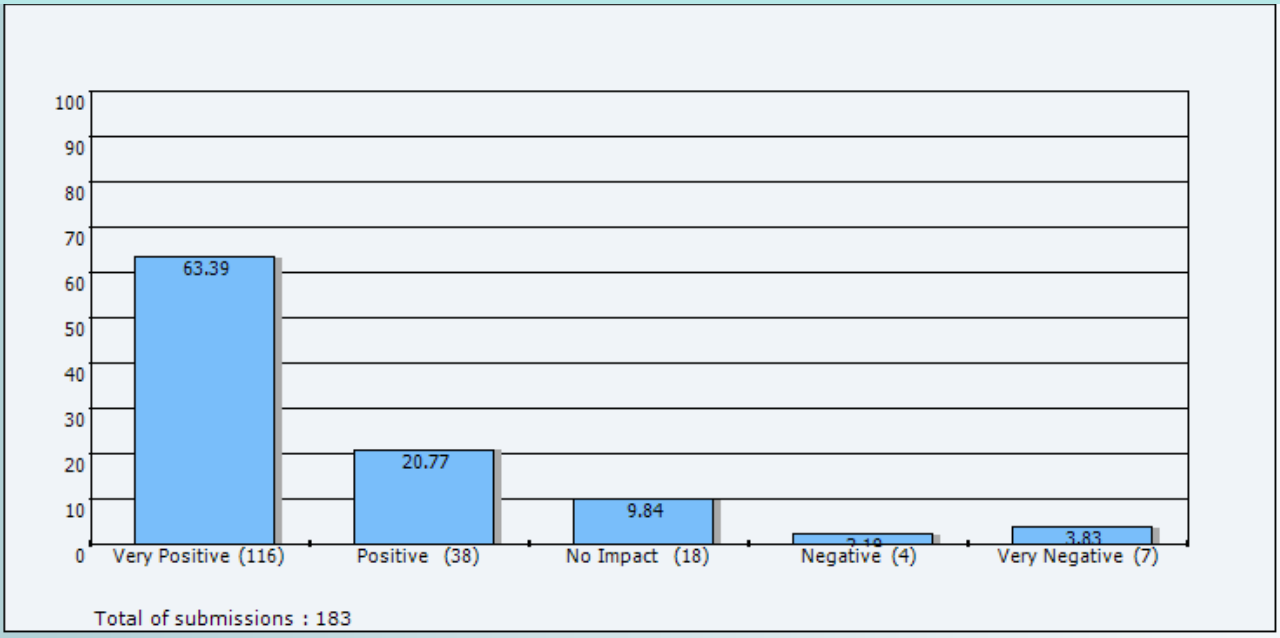
If you live on an Orbit bus route and have experienced the test bus driving by, please tell us your perception of the noise made by the test bus compared to the current buses?



If you live on an Orbit bus route and have experienced the test bus driving by your residence, please indicate your overall experience as a resident of having the test bus in your neighborhood compared to the current buses:



When comparing the current, smaller Orbit buses to the larger test bus, what impact does the larger bus have on the community?*



Please tell us what you like about the MiDi bus.

More seats more room doesnt rattle like the smaller ones
Its looks like an alien futuristicgood job
great
Good replacement for the old bus lots of space
Its alot spaceous
I feel like im going to outerspace
the Seat backs are straight up and supportive, not redining. The ease of entry onto the bus, Especially w/shopping cats. Shock absorbering the rear of the bus. Excellent A/C. Haven't noticed any test bus in my neighborhood. Not being crammed together w/strangers, is a very, very positive experience.
Its bigger better air condition seats more people
Great AC that works comfortable seats lots more room
It looks more like higher class it feels better
Its bigger
Its nice
Ride all when I have errands to run. Very Roomy, more room to pack in more students. The A/C acctualy works. On the other bus they blow hot air and is very uncomfortable
More Room. lots of students during the school year makes it more convient that way your not left at the stop waiting for the next bus. The mercury route needs t alternate the buses.
the A/C its roomie
no bike rack, seats; space. The bus turns like a car very good for driver and passengers
Good ventillation Occupancy
Moe seats for more passengers
Spacious fit more people could fit more wheel chair
I love the air conditioning, the space and seat. I also love that futuristic look and the colors
Looks cool, can fit more people
Everything is much better
They are bigger much quieter the air conditioner system is much better
They are spacious, much better A/C, more seats
Love the larger bus for plaz hours. When I was a student I often had mars pass me at Rural Rd stop because the bus was full some times three times
I really hope you all can give us move of this king of buses
I am disabled the ramp is right at the front door and folds out this makes life a lof easier
Its good especially during the peak time on at the begining of new semester
cooler by far room
big
I am a disable person with a walker and I like the ramp at the front door very important for residents and students
Comfy Seats, bigger, the a/c works better
Seating arragement is much lbetter not as crowded
bigger bus, less waiting time (bus is full less frequently)
the style colors seating windows

Bigger, air conditioning, more seats
more space from others seats are not plastique, as the new blue buses have
More confortable less noisy
It's more bigger and cooler and hope they keep this kind of buses
its more room and the AC alot better then the new ones you just brought out
the air conditioner the space
It is not going to turn into the rattle trap that blue ones always become. This bus is much better built. Forward facing seats are much more comfortable
the room on the bus and the AC is great
Suspension, shock absorption, large windows with no perferated advertisments, pull cords replaced by well spaced stop buttons, increased capacity
The air conditioner
the room and ac
A/C and the room
more room and much better A/C
love it
bigger/nicer in general lots of space
I like it theres more room and the air works
Very nice to ride on
Fun bus
It feels like a bus and trolly mixed. It's quaint and relaxing many seats
the spaciousness and smoothness of the ride
Better than the one now, more room just better, keep these
Its more comfortable and it has better air conditioning
I like th extra room, the design and the colors of the bus. Plus the ACJ is much better I feel more comfortable
Better air conditioning and a lot bigger
looks, comfort, safety
Comfort, Good A/C, Room, Efficient
This particular bus holds enought people and son't go by full when school is in session
More room, and much safer
More head room (I'm 7') more space between patrons, less jostling
The bigger space is much better than the current orbit buses. It has more space in terms of width and length. I also like the fact that it will allow someone on a wheelchair to come into the bus through the front.
it's big enough so I never get "bus full"!
everything
more room, cleaner
It's bigger, fits more people
more seats, more passenger roomm, a/c works better
Accessibility
The size is much better, air conditioned
Like that there is more to sit
Roomy, A/C was fantastic, clean, windowa are big.

It's free, the seats are gay
It is very modern and quiet. Quieter than the old vans.
The AC is really nice. I like that it fits more people, the small buses always end up full. Having two doors is nice when letting people off.
The bigger size is a huge plus. I ride the bus every day to work at ASU and there is rarely a time that I ride that it is not completely full. Bigger busses are definitely a necessity on the Jupiter route.
New and clean.
Seems nice, I like the extra seating. My understanding is that there will be added bike racks which I think is important.
Easier to board and deboard. Better air flow inside. Better ride.
I enjoyed riding the new bus especially on the Mars route because it seems to be a very congested route. The extra seating and standing room is a major upgrade and should be strongly considered.
Better handicapped access
Better drivers navigate speed humps well so the ride is smoother. Pulling cord to request stop illuminates the stop requested sign without loud tone. Wheelchairs positioned at rear provide more seats at front.
The space was so much more convenient. The route I'm on always gets very crowded and frequently I have had trouble getting home due to overcrowded buses.
I like that the center aisle is wider and the material the seats are made of. Also, the lit sign on the side of the bus as well as on the front.
No multi-step entry/exit. Many more seats and additional standing room. Great vision with all the large windows.
Quiet and has great a/c inside..most of the orbit's I ride in the afternoon are full of people and it's full of hot stuffy air because the A/C does not work well. The design of the seating was great..everyone has a button to get off the bus.
more seats and cooler
elegant
i am single mom with a 8 month baby w/stroller so i love the midi bus service it has a nice wheelchair roomy up front and i don't have to fold up the wheelchair
the ride, ore room, gentler, comfortable the air Works!
easy to get on and off, lots of room, new
big feels more secure, easier to board nice a/c
comfort
seat, air contitioning
seats and space, air conditioning
seating, space
roomier, a/c blows good
nice and big
very nice, bus driver was amazing nice, very professional 8/19 @12:30pm
its roomie, ac works and smells good
they have better air conditioning and better seats please keep the new buses i love them
size, looks, cold a/c more modern
everything!
big spaces as well done this size of a normal city bus
Nice inside, and spacious. Sometimes smaller Orbit buses are crowded. Might even encourage more people to ride!
nothing
everything

its bigger
the amount of passengers is far better so then the possibility of me waitng for the next bus is much less
size of vehicle, well maintained, cool air,
Very good
It's free
Smoother ride, more seating
Don't feel like I'm riding a short bus
spacious
Large space
clean roomy and drivers have better work environment
I think it's so cool I think you guys should drive these busses
it is very confortable and roomy I liked it very much
it is one of the best orbits I've been on I love the air conditioning and all the space
It's bigger and more comfortable
I love the new seats, the signage, more seating and wheelchair ramp in the back.
good seat arragements
it feels more safe, new, sanitary and spacious, less likely to be a full bus faster than the old ones
love it
Much more spacious. I like the buttons better than the cords to stop. I like the marquee on the front and side.
newer look, roomier, more comfortable, windows & a/c
It's bigger, better, a/c, stylish
rides smooth, more room and looks better. easier to get on/off
large comfortable seats
Larger
seats
close, convenient, neighborhood oriented, great drivers, here for the community economical, on time, reliable
looks nicer, better a/c seems to have more room especially better seats for the aile
I like that it's spacious and that the AC works better thant the other. This one also runs smoother.
Bigger
More seating
The service
It's much more spacious, the A/C works nicely and with expanced space body heat doesn't travel as far.
They are bigger, more space and they are fresh
very good
more room, more seats
air space good air
it's roomy & colorful
it's bigger and holds more peopls
it's white & bigger
the upper and loer sections

cold air conditioning free ride nice seating
The air conditioning, it's much bigger so we don't have to stand when the bus is full, I like the plush comfortable seats, easier stop notification, I think it's much better
more roomy, comfortable and nice smooth ride
everything
quieter, smooth riding, no cord for stopping, nicer
holds more people, smells better, looks nicer
size, entrance and exit are easy, roomy
more space easy access to exit/entrance, more seating
Cleanliness and roominess
I like the space, and the fact that it shows that Tempe is moving forward in the free transportation department
Can hold a lot more people Air conditioning
It is bigger and looks nicer.

Please tell us what you dislike about the MiDi bus.

nothing really
the prototype has no bike rack
Great A/C
nothing to dislike about the MiDi bus
pretty jerky at stops
its a little slow front window t big needs better sun protection
Thats it
no bike rack
Bike racks would be in issue for alot of riders
we dislike nothing
No bike rack
needs more air conditioner
No bike back
There is no bus rack, needs lower haners handgrips for th short people like on the regular buses
no bike rack
The neighborhoods won't like a large bus lift longer size. You'll have to eliminate the fornt ramp to fit in a fare box. A/C not cool enough and it was on high 10 106 day
too much space for seniors and disabled
doesnt feel as stabel as the olders
Nothing, I like it eh way it is
Nothing they are very good
sometimes the older buses have a really bumpy ride
just give ua a little more cooler AC
nothing
I just love it

seems less sitting space for such a big bus
looks too simmilar to regular city bus; getting to big eliminates the need for smaller/quicker alternative transportaion (orbits are neighborhood based); too similar feel of city bus
Not as comfortable, I get rocked around, more movement
no bike rack AC seems to work well new blue buses have poor AC system
I like it all but I dont like it you guys gave us the bus new bus that sucks
that its not out on the street
its not on the on the street we want these
I know public transporation systems cannot discriminate against riders but the upholstered seating is a breeding ground for the germs and bacteria spread by many transient riders who frequent free rides, comfortable and stylish but, unsanitary.
no bike rack
Not many buttons for the stop
Should not have fabric seats, contamination problems, should have seats like the light rail
The cooling system is not well engineered. Whenever you sit a blade of high pressure cold wind hits your head it should be distributed.
Too big for the neighborhood, no bike rack, you should just give the bus drivers raises instead.
overcrowded, drinking, being left
Miss the blue paint. Brakes are harsh, stopping hurts, stop buttons are too far apart/not enough
It is not painted blue, and many riders call the Orbit "the blue bus"
How is the Orbit successful? Is it packed 24/7? At any given time in my neighborhood I see 2 maybe 3 people riding the Orbit. Why do we need yet another FREE bus for taxpayers to pay for? Are you expecting an influx of low income people into Tempe who will be riding this midi bus? I don't ride the Orbit and I would not ride the Midi. I don't want to pay for the Orbit and I don't want to pay for the Midi. 41 million for Tempe Town Lake, property taxes going up, water rates going up, Medicaid Expansion, bond overides "for the children", and now this. I don't have any more money to give you. I vote no on the Midi. I do not know what route I live on because I don't ride it.
The stop buttons are kinda awkward, having them more often or a cord would be better. It would also be nice if they had some form of bike rack.
These buses do not have enough fuel capacity to last all day. This means i am frequently delayed while waiting for a bus replacement due to low fuel.
When we were told about the Orbit buses being in our neighborhood, it was stated they would not be large buses. The new buses are large. There are rarely more than two or three riders on the Orbit bus that passes my residence. This is wasteful enough and does not justify an even larger bus. Please keep your word to residents and not place larger buses into service. Please be responsible with the taxpayers money and not spend it on something that isn't needed.
Note that the survey required me to provide an answer question No. 9 in spite of my indication in question No. 5 that I had not ridden the test bus. I like the look to the larger test bus and its increased size.
Too Big!
Maybe a few more stop buttons located through out the buss
No bike rack Uses diesel fuel Noisier
1. Air conditioning is loud and does not cool adequately. One very hot day departing Tempe Marketplace, passengers with driver consent opened all of the windows to get some relief. Suggest redesigning the way air flows, if it is indeed generating enough cooling. 2. There are no hanging straps and widely spaced poles make it hard to walk safely within the bus. 3. Wheelchair lift rattles. We have endured this problem with existing vehicles - let's fix the problem, please. 4. Shorter height, vehicle width and overall cubic capacity makes cabin crammed when full capacity. That is unpleasant enough without strollers and groceries and children. We are not all in college carrying

backpacks. 5. If 2 wheelchair passengers are loaded in an emergency, how will frightened passengers escape via emergency exit window - by climbing over them? - How long will it take to evacuate them and all passengers with/without driver assistance through the emergency window?
No bike racks! How can you even think of putting a bus on the Orbit route without bike racks?? Do you have any idea at all of the number of people who use bike racks who ride the Orbit? Do you realize that the Orbit route serves a large population of students, MANY of whom use bikes? I think it is ludicrous and incredulous that you would even think of putting buses on Orbit routes without bike racks. Please do not implement these new buses if they don't have bike racks on them!!
The number one dislike is the air conditioning system, it is extremely loud and does not do a good job of cooling. When sitting in the side seats you barely feel the air unless the bus is turning. When the bus turns the cool air wafts over you and as the bus straightens out you don't feel the coolness anymore. The four back seats are the coolest but the ride is very rough back there. I also think the seats are less comfortable
Not enough 'stop buttons' to signal driver of your intent to de-board.
The larger buses do not belong in neighborhoods. They are too much like the huge city buses....louder and more pollution. There are a lot more vagrant folks around now that they can hope on a free bus and ride in air conditioning all day. I realize the last fact has little to do with the size of the bus. But bigger buses could lead to more vagrants. The small buses look and feel like a neighborhood bus. PLEASE PLEASE PLEASE do not bring large buses into small neighborhood streets.
no bike rack
no bike rack, this bus is to big for the community, neighborhod
no bike racks
seems sluggish compared to the small ones
nothing it's great
Concerned about environmental impact of larger buses. I think any new vehicles should be "greener" than the ones they replace. I also disliked that the prototypes don't have bike racks (but understand that future replacements would).
too big to be going down neighborhood streets
it is too slow
I do not see a bike rack and the orbit is my life line along with my bike
nothing so far
No bike rack
nothing so far
nothing, except they should play music and the stop button needs to be louder
I love everything about it.
i wasn't sure if it was an orbit bus at first
The starts and stops feel a lot harsher
no complaints
not enough of these buses
kinda long, bell not loud enough
Older ones were crowded. New ones will be easier for wheel chairs and people with mobality issues.
could use more stop buttons, bike racks
No bike racks, Don't like the forward feeling seat pairs, less convenient to get past someone, not a smooth ride, prefer shorter buses
Some of the drivers could be nicer
No bike racks or visible wheelchair lift
bus costs more
needs more buttons for stopping

i dislike nothing!
nothing
unable to easily see out the windows where I am
No windows to open, I love the air conditioning however there are some questionable people that get on that smell terrible, it's nice to open a window to vent
not enough room for people to get off when people are standing up
NO BIKE RACK! bikes are an important part of ecofriendly transportation
needs a bike rack!! A MUST
The air conditioner is far too weak for this climate.
No bike rack Would like to get more information on the environmental impact between the old orbit buses and the new prototype
No bike rack.
The numbers don't add up. The MiDi buses are 20% bigger (in terms of floor space), but they're supposed to hold twice as many people.
The Orbit goes by our house 85 times a day. There is never anyone on it. There are two (2) schools by us. One is on Southern and Dorsey, a charter school and the other is the grade school a block south of that on Dorsey and Malibu. The Orbit goes by there when there are alot of kids walking and biking home to and from school as well parents dropping and picking us kids. It is too much traffic and dangerous. The Orbit should stop at the regular bus stop on Southern and Dorsey by the charter school. This would eliminate all the traffic and more important the chance of a child being hit.

Orbit Neighborhood Circulator Fleet

Transportation Commission
May 12, 2015

City of Tempe
PUBLIC WORKS

Orbit Capacity Challenge Background

- High ridership
- Current capacity: 23 passengers
- Limited on/off activity – buses fill as they approach Downtown & ASU
- Most common complaint: boarding denial due to overcrowding
- Mercury & Jupiter most prone to overcrowding
  - Mercury: increased frequency to 10 minutes from 6 am to 6 pm weekdays
  - Jupiter: when available, standby buses sent to pick up missed passengers

Midsize Bus Test Program

- Partnered with New Flyer, a leading bus manufacturer
  - Tempe opportunity: test a slightly larger bus; gather passenger and community feedback at np cost to Tempe
  - New Flyer opportunity: test new product in a real-world setting
- One test bus: 30-foot New Flyer MiDi that rotated all Orbit routes from July - December 2013

MiDi Test Bus

Midsize Bus Test Program

- Community feedback to assess acceptance of the larger vehicle type
  - Community meeting with bus on display
  - Comment cards for passengers on bus
  - Information and survey on Tempe website
  - Input from bus operators and mechanics

Community Feedback

- 289 survey respondents
- 83% live along an Orbit route
- 95% are Orbit riders
- 85% indicated that their overall experience was better on the test bus
- 78% stated that the noise levels were the same or less than the current buses

Community Feedback

- 81% reported that the presence of the test bus driving in their neighborhood was the same or better than the current buses
- 83% indicated that the test bus (compared to the current bus) has a positive impact on the community
- Most common negative feedback was the lack of a bike rack, which will be included on production models.

Next Steps

- If approved, larger buses (similar in size to the test bus) would be implemented in stages beginning in 2017
- Plan includes continued use of smaller buses on some routes
- Powered by an alternative fuel (CNG)
- Heavy duty rather than medium duty as tested
- Life cycle cost is anticipated to be comparable to smaller buses
- Funding: majority federal; local match from Prop. 400
    - No anticipated impact to Tempe local transit funds

CITY OF TEMPE
TRANSPORTATION COMMISSION

STAFF REPORT

AGENDA ITEM 6

DATE
May 6, 2015

SUBJECT
Alameda Drive Bicycle/Pedestrian Design Concepts Project

PURPOSE
The purpose of this memo is to provide the Commission with an update on the Alameda Drive Bicycle/Pedestrian Design Concepts Project.

BACKGROUND
The Alameda Drive Bicycle/Pedestrian Design Concepts project is an east/west connection in Tempe between Rural Road and 48th Street at the Phoenix border and will involve creating design concepts to begin re-characterizing three miles of a very wide collector street with no current bike or pedestrian amenities other than signage into a premier pedestrian area and bicycle boulevard, while retaining vehicular access. Design concepts are the first phase in project development and are used to seek federal grants for construction. The Alameda Drive Project is identified in the Tempe Transportation Master Plan and has some of the highest east/west bicycle ridership numbers in Tempe according to Tempe Bicycle Action Group. The project links directly to Phoenix and bike lanes on Roeser Road. Alameda would ultimately link to Mesa and the 8th Street bikeway, across the 101 freeway with a bike/pedestrian bridge that is proposed over Balboa Drive, but not yet funded.

The project also links directly to the location of a bike/ped bridge over the I-10 at Alameda Drive and connecting to Diablo Stadium that is now funded as part of ADOT's near term improvements to the interstate. The project connects to 10 transit routes, including some of the busiest bus routes (72) and Tempe's Orbit system. This collector street also links directly to two schools, established neighborhoods as well as major industrial/employment areas like Fountainhead.

A public meeting will be held on May 6. Public comment is available online at www.tempe.gov/alamedadrive from May 6 to June 7, 2015. Additional public meetings will occur in September and November.

FISCAL IMPACT
This project will eventually transform the street from a wide corridor and introduce landscaping, ADA and sidewalk improvements, lighting, enhanced street crossings, traffic calming, buffered or protected bike lanes and green bike lanes like other Tempe projects. $75,000 has been secured for design of the project from a grant through the Maricopa Association of Governments.

RECOMMENDATION
This item is for information and input.

CONTACT
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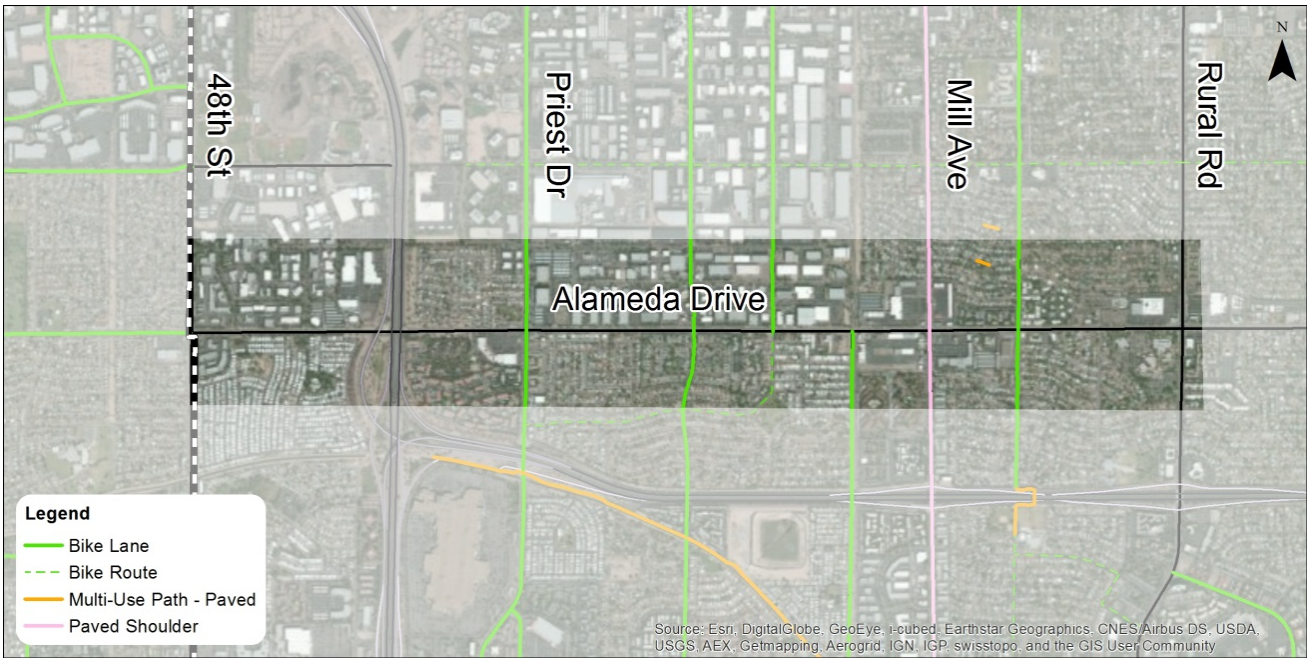
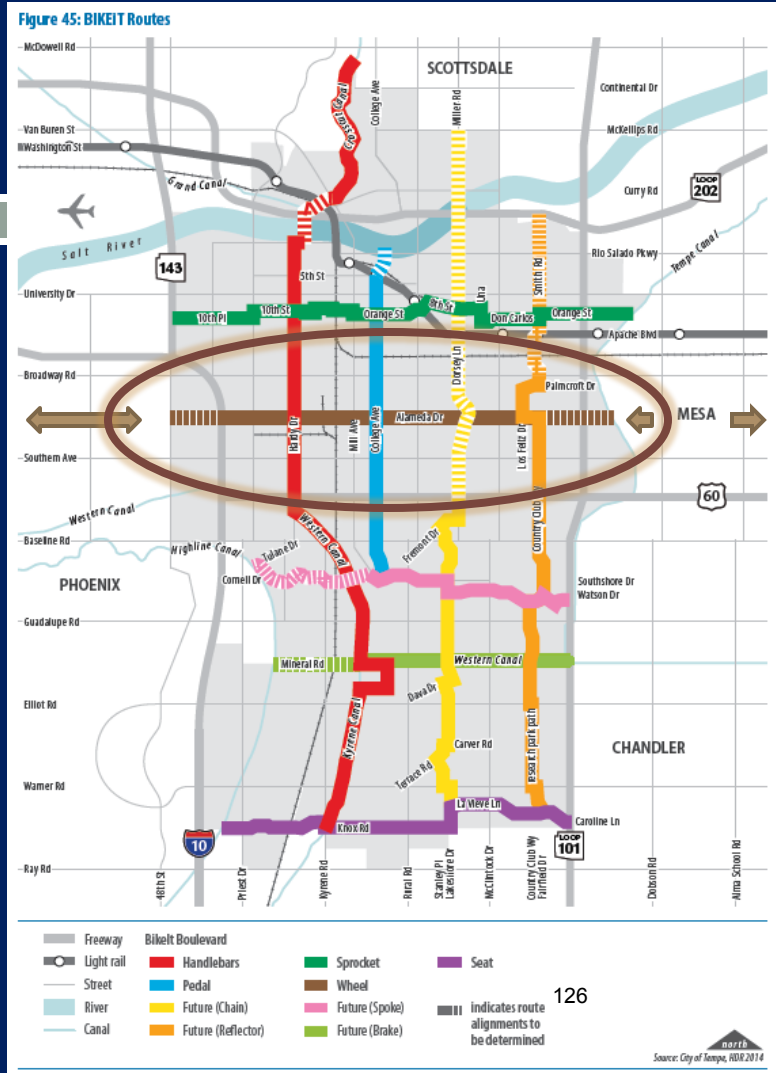
ATTACHMENTS
Project Area Map, Powerpoint Presentation



Alameda Drive Pedestrian and Bicycle Design Concepts May 6, 2015

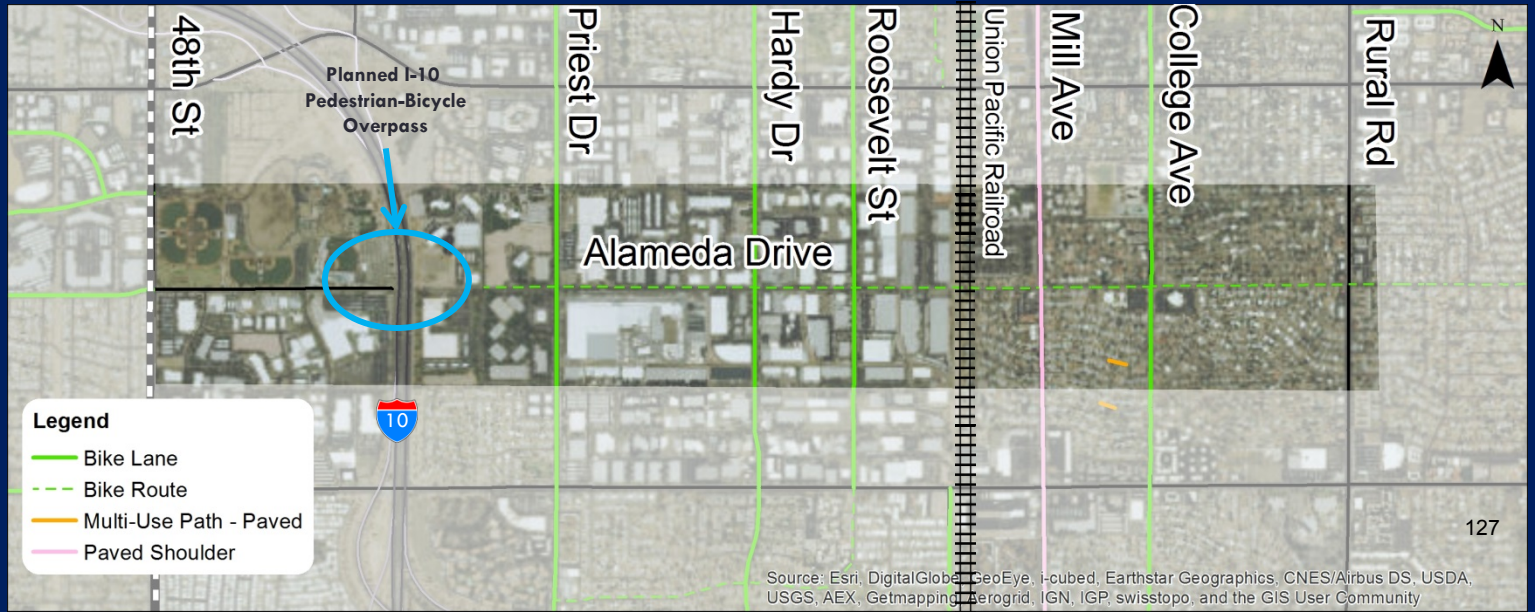
Background

- Alameda Drive corridor is part of the bike boulevard network in the Transportation Master Plan
  - Alameda is regionally significant with connections to Phoenix & Mesa
- Funding for planning obtained from the Maricopa Association of Governments (MAG)
  - **No construction funding identified**
- **Project scope….**
  - **Collect transportation data**
  - **Develop pedestrian/bicycle concepts and have public input on concepts**
    - **3 public meetings**
  - **Create a 'Preferred Alternative'**

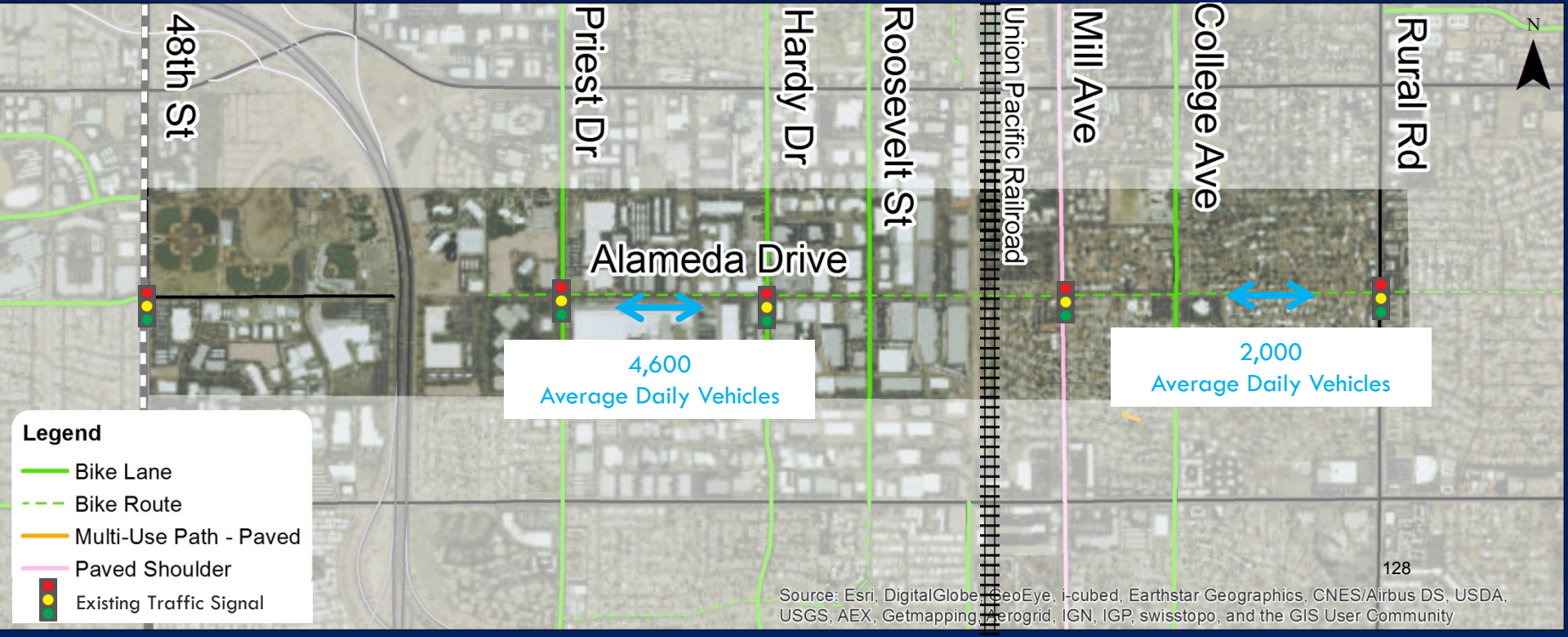


Background

- Alameda Drive traffic characteristics are ideal for pedestrian/bicycle movements:
  - Low vehicle traffic volumes - Regional pedestrian/bicycle connectivity - Non-continuous vehicular route



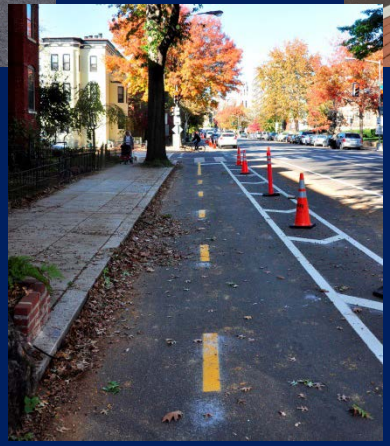
Existing Traffic Conditions



Possible Facility Improvements

"Sharrows"

Buffered Bike Lane



Two-Way Bike Lane

Protected Bike Lane

Possible Facility Improvements

Median Refuge

Bicycle Signal

Transit Stop Amenities

Raised Crossing

Community Improvements Input

- Which type of potential improvements best support your activities?
- Please point out existing concerns/issues to the project team!

Thank you for your Feedback!

Tracks
Westbound

CITY OF TEMPE
TRANSPORTATION COMMISSION

STAFF REPORT

AGENDA ITEM 8

DATE
May 12, 2015

SUBJECT
Future Agenda Items

PURPOSE
The Chair will request future agenda items from the commission members.

BACKGROUND
The following future agenda items have been previously identified by the Commission or staff:

- Bicycle/Pedestrian Signal Activation Operation (June)
- Bus Unification (June)
- City Tentative Fiscal Year 2015-16 Operating Budget (June)
- MAG Congestion Mitigation and Air Quality Program (CMAQ, ITS) & Pedestrian Design Assistance Grants (June)
- Streetcar (June)
- RPTA/Valley Metro Southeast Valley Transit Study (June)
- Street Closure Procedures and notification follow-up (August)
- Highline Canal Multi-use Path (August)
- BikeShare (August)
- Orbit Saturn (August)
- Bike Boulevards (September)
- North/South Railroad Spur Multi-Use Path (September)
- Orbit Saturn (November)
- Alameda Streetscape Project (November)
- Long-Range Forecast Presentation (November)
- Introduction of CIP Requests (December)
- Bike Hero (January)
- FY 2016/17 Media Plan (February)
- Long-Range Forecast Update (Operating) & CIP follow-up (March)

FISCAL IMPACT
None

RECOMMENDATION

This item is for information only.

CONTACT

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City Annual Budget Planning Process

Council/Public Input Dates	Topic	Transportation Commission Input/Info. Dates	Action Requested by Transportation Commission
August	Issue Review Session – Budget Strategy Update	**n/a**	
October	Issue Review Session – Long-Range Forecast Presentation	**November**	Commission provided a copy of the long-range forecast.
November	Committee of the Whole – Budget Discussion Follow-up	**n/a**	
Early February	Issue Review Session – Introduction of CIP Requests	**December**	Staff requests that the Commission review and provide input regarding Transportation CIP requests.
Mid-February	Public Meeting(s) – Budget (Operating and Capital Budgets)	**n/a**	
Late February	Issue Review Session – Long-Range Forecast Update (Operating) & CIP follow-up	**March**	Commission provided with an update on Operating and CIP discussion.
Mid-March	Issue Review Session- CIP Discussion	**April**	Commission provided with an update on the CIP discussion.
Late April	Issue Review Session – FY 2014-15 Operating Budget Review	**n/a**	
Late May:	Council considers adoption of Tentative Fiscal Year 2015-16 Operating Budget	**June**	Commission provided with an update on the tentative adoption.
Early June	Council considers adoption of Final Fiscal Year 2015-16 Operating Budget and Public hearing and adoption of the Fiscal Year 2015-16 Capital Improvements Program	**n/a**	

MAG Annual Grant Process

Timeline	Grant Type	Transportation Commission Input Dates	Action Requested by Transportation Commission
Annually released in Early to Mid-February and due in Early to Mid-March	FTA Section 5310 - Grant for transportation for elderly and persons with disabilities.	**November**	Staff requests that the commission review and provide input regarding proposed project.
Annually released Early March and due in late April	Transportation Investment Generating Economic Recovery (TIGER) – Federal Department of Transportation discretionary grant program. Total available funds nationwide was $600 million for 2014. Regional projects are solicited by MAG.	**November**	Staff requests that the commission review and provide input regarding proposed project.
Annually released in late May and due in late June	MAG Pedestrian Design Assistance Grants	**May & June**	Staff requests that the commission review and provide input regarding proposed project.
FY 2015 or 2016	Highway Safety Improvement Program (HSIP) – There is a state portion (ADOT) and a regional portion (MAG). ADOT accepts requests for state funds on a continual/ongoing basis. Selections are based on safety needs and data. MAG regional funds are currently programmed through FY 2017.	**Not Applicable**	Based on historical safety data, staff has already identified the intersections of Rural Road & Southern Avenue and Rural Road & University Drive as priorities for future HSIP funding.

February 2015	Urbanized Area Formula Program (5307) – Administered by Federal Transit Administration and pays for capital projects such as transit facilities and rolling stock. Most of the funding is committed to pay for transit improvements identified in the MAG Regional Transportation Plan. Unspent portion of the funds are offered by MAG every two years via competitive grants.	**November**	Staff requests that the commission review and provide input regarding proposed projects.
March 2015 with full solicitation, every 3 years	Congestion Mitigation and Air Quality Program (CMAQ) – Bike and Pedestrian Improvements; PM2.5; Transit; Street Sweepers.	**November**	Staff requests that the commission review and provide input regarding proposed project.
Mid-March 2016 and due Mid-April, every 2 years	Job Access Reverse Commute (JARC) – Projects that are eligible must demonstrate improved job access for low income population.	**November**	Staff requests that the commission review and provide input regarding proposed project.
August 2016 and due in mid-September, every 3 years:	Transportation Alternatives Program (TAP) - Bike and Pedestrian Projects	**November**	Staff requests that the commission review and provide input regarding proposed project.
ON HOLD Released in August and due in September	Congestion Mitigation and Air Quality Program (CMAQ ITS) are Federal fund for ITS projects. Projects are selected based on air quality scores and committee member scores. Programming is set through FY 2017. It is not known at this time how the arterial ITS program will proceed.	**June**	Staff requests that the commission review and provide input regarding proposed projects prior to call for projects in August.