

SUSTAINABLE CITY MOBILITY INNOVATIONS

KINGSTON, NEW YORK

MAY 2019

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Executive Summary

Our capstone team assisted NYSERDA in its goal to increase the presence of smart mobility solutions in small cities, a key market segment for the organization. Under the direction of NYSERDA's Clean Transportation team, our work focused on the City of Kingston, NY. To arrive at a final recommendation, the team conducted a needs assessment, surveyed emerging smart mobility solutions, and evaluated potential solutions against three core values — sustainability, financial viability, and system-wide synergy.

The final proposal recommends four initiatives — City Fleet, Walk Kingston, Smart Parking, and Signal Priority — and includes implementation plans and financial models to pilot each initiative. In addition, the report considers a range of sustainable mobility enablers that will be essential to implementing the initiatives, including governance strategies, additional financing sources, and regulatory considerations. The combination of initiatives and enablers is designed to improve mobility, lower emissions, and boost economic development.

Although the recommendations are tailored to meet the needs of Kingston, our methodology and models can be replicated to accommodate other similarly sized cities. While we aimed to design specific pilots that could be implemented in Kingston in the near-term, we also aimed to provide a playbook for evaluating mobility innovations more broadly.

— Objectives & Methodology

SUSTAINABLE MOBILITY

In 1991, the United Nations defined a sustainable city as one “where achievements in social, economic, and physical developments are made to last.”¹ In 2013, the UN expanded that definition, adding that a sustainable city can only be achieved by integrating the four pillars of social development, economic development, environmental management, and urban governance.²

Sustainable mobility is a critical part of the sustainable city, intersecting with each of those four pillars. Socially, mobility is essential to visiting friends and family and investing in relationships. Economically, mobility empowers our daily commutes to the workplace. Environmentally, mobility systems can generate sprawl and greenhouse gas emissions (GHGs) or can instead be designed to promote density and active transportation that reduces per person emissions. Together, urban governance structures are necessary to design, implement, and manage mobility systems that bring these components together to serve public needs with equity, efficiency, and innovation.

Historically, mobility systems have failed — prioritizing automobile throughput to the detriment of creating walkable public spaces and vibrant, inclusive neighborhoods. As Former NYC Department of Transportation Commissioner Janette Sadik-Khan writes:

“Streets for the last century have been designed to keep traffic moving but not to support the life alongside it.

Many streets offer city dwellers poor options for getting around, discouraging walking and stifling vibrancy.”³

But new ways of thinking are beginning to emerge. Complete Streets groups are pushing for design solutions that incorporate safety, walkability, and street-level activity.⁴ The National Association of City Transportation Officials’ Urban Street Design Guide has codified new best practices for designing streets that are “safe, sustainable, resilient, multimodal, and economically beneficial, all while accommodating traffic.”⁵

Similarly, new thinking is emerging for how residents will navigate this new street network. From cycling to public transit, Dr. Steven Cohen from Columbia University’s Earth Institute writes that “a sustainable transit system will have to include personal transit options that are less polluting than current internal combustion-based vehicles.”⁶

As this report considers smart city deployments, it is important to think beyond a technocentric perspective of urban innovation. The latest technology will be a key determinant of success, although, not a panacea. Cities adapt and adopt innovation through technology, process, governance, regulation, and collaboration.⁷

Together, considering each component of a mobility system — from street design to transportation mode — is essential to generating the network effects that can emerge from a successful sustainable system.

1 Steven Cohen, *The Sustainable City*, Columbia University Press, 2018, p 4.

2 Steven Cohen, p 4.

3 Janette Sadik-Khan, *Street Fight - Handbook for an Urban Revolution*, Penguin Books, 2017, p 1.

4 “Boston’s Complete Streets,” Boston Department of Transportation, accessed 2019, <http://bostoncompletestreets.org/guidelines/CompleteStreetsAdvisoryCouncil>, City of Kingston, NY, accessed 2019, <https://kingston-ny.gov/CompleteStreetsAdvisoryCouncil>.

5 “Urban Street Design Guide,” National Association of City Transportation Officials, accessed 2019, <https://nacto.org/publication/urban-street-design-guide/about-the-guide>.

6 Steven Cohen, p 131.

7 André Corrêa d’Almeida, *Smarter New York City, How City Agencies Innovate*, Columbia University Press, 2018, p 2.

“to assess the technical and financial feasibility of implementing smart mobility solutions in a small city”

OBJECTIVES

NYSERDA is responsible for managing the State’s Clean Energy Fund (CEF) — a primary vehicle for achieving the state’s aggressive sustainability goals.⁸ The CEF designates funds for Clean Transportation, with the explicit goal to “support the development and demonstration of new technologies and strategies to reduce GHGs from the transportation sector and to gain market traction for these products to advance their use to the point at which the market no longer requires NYSERDA’s interventions.”⁹

In partnership with NYSERDA’s Clean Transportation team, our capstone’s objective was to assess the technical and financial feasibility of implementing smart mobility solutions in a small city — Kingston, NY. For the scope of the project, we considered solutions that could be implemented in the near-term, under five years, and that could be financed for less than \$5 million dollars.

⁸ “Clean Energy Fund,” New York State Research and Development Authority, accessed 2019, <https://www.nyserderda.ny.gov/About/Funding/Clean-Energy-Fund>.

⁹ “NYSERDA Clean Energy Fund Investment Plans - Clean Transportation Chapter,” New York State Research and Development Authority, November 1, 2017, <https://www.nyserderda.ny.gov/-/media/Files/About/Clean-Energy-Fund/CEF-Clean-transportation.pdf>.

M E T H O D O L O G Y

Our eight-step methodology included initial information gathering, diagnosing key findings, evaluating potential solutions, and finally, developing detailed implementation plans.

1. INTERVIEW STAKEHOLDERS AND COLLECT DATA TO INFORM DIAGNOSIS

We met with stakeholders in relevant City departments, including finance, transportation, sustainability, health and wellness, and IT. By interviewing leaders we identified common issues and developed a sense of the City's vision for mobility. In addition, we used existing data, program audits, and planning reports to understand historical context, current challenges, ongoing initiatives, and future goals. If more time were available, we would recommend conducting additional ethnographic analysis with residents and employers to better understand mobility needs.

2. DRAFT KEY FINDINGS

After completing initial research and collecting stakeholder input, we drafted key findings that articulated our understanding of core challenges. The key findings were essential to guiding our evaluation of potential solutions. These findings were presented to all stakeholders, and feedback was collected to diagnose problems accurately.

3. DEFINE MISSION AND VALUES

In addition to diagnosing problems, we used stakeholder input to define the project's mission and the core values that would shape our evaluation. The values provide a roadmap for what success looks like. Where possible, each value was tied to a key metric that could be used to measure progress.

4. IDENTIFY SCOPE OF RELEVANT TRANSPORTATION DOMAINS

In order to narrow the scope of our research, we identified the transportation domains that were relevant to our City. In this regard, every city may be different, often depending on geography,

density, and climate. For some cities transportation domains like rail, air, and maritime transit may be critical; however, others cities may not require these domains.

5. LANDSCAPE MOBILITY SOLUTIONS AND BEST PRACTICES

After defining the relevant transportation domains, we conducted a landscape of existing best practices and emerging innovations in each domain. Where possible, case studies were identified.

6. EVALUATE MOBILITY SOLUTIONS

Each identified solution was evaluated according to its alignment with each of our defined values. A scoring matrix was used to compile all evaluations and create a method for comparing the various solutions (For Solutions Evaluation Matrix, refer to Appendix A).

Ratings included:

- + 1 positive alignment with the value
- 0 neutral or unobserved alignment with the value
- 1 negative alignment with the value

7. PRIORITIZE MOBILITY SOLUTIONS

After rating all potential solutions, we compiled a short-list of the solutions that were most capable of achieving the project's goals. In addition, we considered how identified solutions might be grouped, overlapped, or redefined in creative ways to generate increased benefits.

8. DEVELOP PILOT INITIATIVES

Finally, we developed pilot programs to implement and test each solution. Rather than creating long-term plans, we wanted to produce low-cost, low-risk initiatives that could be rolled out in the near term. The goal was to allow each city to test ideas in its own local context — understanding that what works well in one city, may not in another. Each pilot includes an implementation plan and a financial model.

IN CONTEXT:

Kingston,
New York

KEY FINDINGS

1. Kingston over-relies on cars as its primary mode of transportation. Kingstonians regularly use private automobiles to complete short trips and commute to work.

Kingstonians regularly use automobiles to complete trips under one mile. There are many challenges to spurring a mode shift that scales back automobile usage. In particular, residents will need transportation alternatives that rival the convenience and affordability of private car ownership.

As of 2010, the transportation sector is responsible for 40% of Kingston's GHGs, reporting 158,782,140 vehicle miles traveled (VMT), according to the City's 2010 Greenhouse Gas Emissions Inventory.¹

Kingston's Climate Action Plan set the goal of reducing single occupancy vehicle use by 20% by 2020.²

The 2015 American Community Survey (ACS) found that 20% of Kingston households do not own a car. However, the 2016 Consolidated Transportation Plan reported that number to be 39% for the City of Kingston. The size of this population suggests that non-auto transportation networks could be viable in Kingston.³

Although car-share programs like Zipcar were explored in the past, Kingston was unable to find a willing private partner.

The City has begun to invest in electric vehicle (EV) infrastructure, installing 6 EV charging stations (9 in Ulster County). The municipal fleet has 9 Electric Vehicles. The Green Fleet program has set the goal of having 20% of municipal fleet as alternative fuel vehicles by 2020.⁴

1 City of Kingston, "Climate Action Plan," September, 2012, [https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_\(1\).pdf](https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_(1).pdf).

2 Ibid.

3 "Ulster County Coordinated Public Transit-Human Services Transportation Plan," Ulster County Transportation Council, February, 2017, <https://ulstercountyny.gov/sites/default/files/documents/planning/ULSTER%20CO%20HSTCP%20Update%202016%20FINAL.pdf>.

4 "Transportation," City of Kingston, accessed May 2019, <https://kingston-ny.gov/content/8399/22301/22342/default.aspx>.

2. Kingston's public transit system is in the process of merging with the county system to improve service. However, many challenges remain in providing adequate frequency and coverage to city residents.

Kingston's Public Transit system is experiencing an important transition, despite historically poor service quality, the system's merger with UCAT is a first step in establishing a viable transit service. Nevertheless, to provide levels of service that meet Kingston's requirements, the UCAT system will require innovation.

The merger of Citibus and UCAT is going to take effect in July 2019. Nearly all interviewees were supportive of the merger between Citibus and Kingston.⁵

Citibus has had poor service levels, with waits reaching one hour, aging bus fleets, and routes that do not meet community mobility needs. Ridership has continuously declined in recent years; and the

lack of a modern user experience (apps, scheduling, or arrival time data) led to poor service.⁶

In contrast, UCAT offers improved levels of service, and ridership has increased in recent years. UCAT's service area offers extensive regional coverage and includes user benefits like a real-time mobile app and Wi-Fi access on all buses.⁷ Interviewees were supportive of potentially integrating additional modes of transportation in the mobile app (e.g., ride-hail, car-share, and bike-share).

UCAT plans to operate three bus routes that will run through Kingston.⁸

5 J. Smith, Jesse, "Kingston Common Council OKs plan to merge city and county buses," March 11, 2019, <https://hudsonvalleyone.com/2019/03/11/kingston-common-council-oks-plan-to-merge-city-and-county-buses/>.

6 Ulster County Transportation Council, "Rethinking Transportation: Plan 2040," October, 2015, https://ulstercountyny.gov/sites/default/files/documents/planning/LRTP_Final%20Report.pdf.

7 Ibid.

8 Kirby, Paul, "UCAT-Citibus merger goes to Ulster County Legislature this month," Daily Freeman, April 6, 2019, https://www.dailyfreeman.com/news/local-news/ucat-citibus-merger-goes-to-ulster-county-legislature-this-month/article_5361e04a-56fc-11e9-a580-af8595f81140.html.

3. Despite its small size, Kingston is not as walkable as it could be.

Improving pedestrian accessibility and creating vibrant pedestrian spaces is a priority and a challenge for Kingston.

Sidewalk rehabilitation is a challenge, particularly to achieve ADA compliance, with an estimated 81 miles of sidewalk infrastructure in need of repair. Historic, blue-stone sidewalks can be particularly challenging to replace. Residents prefer to maintain neighborhood character; however, the blue stone is significantly more expensive.⁹

Pedestrian connectivity from Uptown to Downtown is limited. In particular, destinations like Kingston Point are difficult to reach by foot.

Several major avenues were observed as not having sidewalks, including Flatbush Ave. and East Chester St.¹⁰

The Complete Streets Advisory Council is working to re-envision pedestrian spaces in Kingston, with the Broadway Streetscape Project as a principal first focus.¹¹

A Sidewalk Improvement District is currently being considered to establish property owner fees in order to fund sidewalk repairs. The fees are

estimated to raise \$1 to \$2m, which would fund repairs over 30 years. The proposal is subject to public referendum and could face criticism if viewed as an additional tax.¹²

While the City has launched Bike Friendly Kingston, there are few advocacy efforts focused on pedestrians. However, a new Health and Wellness Department was established to work on promoting pedestrian activity.

The Walking School Bus program along Henry St. is popular for George Washington Elementary School kids walking to school, particularly because school bus transportation is only provided to elementary students who live more than ¼ mile away. Infrastructure improvements are planned for this street to continue improving pedestrian space.¹³

Kingston recently received grant funding to create a Pedestrian-Bike Master Plan; however, the project is only just beginning.

There are several retail districts that could be strong for pedestrian-priority pilots, including the Uptown Stockade District, the Downtown Restaurant District, and Midtown's retail corridor along Broadway.

9 Interview with City Officials, February 8, 2019.

10 Site Visit in Kingston, February 8, 2019.

11 "Broadway Streetscape Fact Sheet," City of Kingston, February 1, 2017, https://kingston-ny.gov/filestorage/8399/8469/26768/16365/Broadway_Streetscape_Factsheet_2-1-2017_rev1.pdf.

12 Interview with City Officials, February 8, 2019.

13 Ibid.

4. Kingston's size is optimal for active and micromobility solutions. Support for a shift to micromobility is aided by planned infrastructure investments and emerging advocacy institutions.

Kingston's size makes it extremely favorable to micromobility (including biking, scooters, skateboarding, roller-blading, etc.) with many trips under one to two miles in length.

Kingston does not have any designated bike lanes; however, the City did significantly invest in established sharrows — or shared bike and automobile lanes.¹⁴ Separated bike lanes are proposed for both the Broadway Streetscape Project and the Henry St. redevelopment project.

The Greenline project aims to redevelop old rail lines into an interconnected network of trails for bikes and pedestrians that becomes a viable transportation system connecting Uptown, Midtown, and Downtown.¹⁵

Weather and steep street grade are challenges for active transportation in Kingston. The Greenline

Project could assist in some ways by providing tree cover and gradual grade changes.

There is some resistance to road diets that would create designated bike lanes. For example, when the Broadway Streetscape Project proposed swapping parking lanes for bike lanes, the proposal was rejected.¹⁶

The City's Bike Friendly Kingston campaign has established a strong biking advocacy group. While there is still some anti-biking sentiment, new demographic groups including immigrants and residents from metropolitan cities have been supportive of improving bikeability in Kingston.¹⁷ Kingston does not currently have e-scooters, e-bikes, or bike-share, but the City expressed interest in building out these services.

14 "Projects on the Kingston Greenline," City of Kingston, accessed May 2019, <https://www.kingston-ny.gov/kingstongreenline>.

15 Ibid.

16 Interview with City Officials, February 8, 2019.

17 Bike Friendly Kingston, accessed May 2019, <http://www.bikefriendlykingston.org/>.

5. Parking space in Kingston's commercial districts is in short supply. The introduction of parking meters has been a positive step, but parking and land-use remain a challenge for the City.

Parking space in business districts is scarce, and residents are hesitant to convert street parking into bike or pedestrian lanes. When considering options for balancing availability with sustainability goals, the impact of parking location, price, accessibility, and enforcement should be thoughtfully considered.

The City is working to update zoning regulations related to parking, particularly to improve ability to build denser parking structures and to change parking spot requirements for buildings.

In business districts, Kingston parking meter kiosks collect mobile payments using the Whoosh! App, which integrates with the City's ticket writing software. As of early 2019, roughly 15% of parkers paid with the Whoosh app. Parking meters in business districts were important for promoting circulation and retail activity. The City also offers a \$100 annual permit for parking in business districts.

A lack of loading zones creates a challenge for goods movement, as delivery trucks double park or block lanes to complete last-mile deliveries.¹⁸

6. Kingston's street network is outdated and complex. The City's traffic signaling system and lane allocation could also be improved to increase throughput while still supporting sustainable mobility goals.

Kingston's street grid requires significant attention as the City adds bike lanes, wider sidewalks, and safer cross walks. Additionally, the City's traffic signaling network is in need of modernization. Kingston's street composition prioritizes automobile traffic; there are few other modes represented in the existing street network.¹⁹

There are several intersections where pedestrian safety is a concern, as crosswalks and other pedestrian infrastructure is lacking.

Kingston experiences significant congestion at peak hours, particularly in the areas around the I-587 intersection with Broadway.²⁰ The NYSDOT is currently managing a project to redesign the intersection so that it operates as a roundabout.²¹

Kingston's traffic signaling system is prone to malfunction. While some signals are modern, others are quite old — there's a wide variety. In addition, signaling could be better optimized to work as a single system.²²

19 Site visit in Kingston, February 8, 2019.

20 Eng-Wong, Taub, and Associates, "Mid-Hudson Valley TMA Travel Time Survey," October 7, 2011, <https://ulstercountyny.gov/sites/default/files/documents/Mid%20Hudson%20Valley%20Meeting%20Presentation%202010-7-11.pdf>.

21 Interview with City Officials, February 8, 2019.

22 Ibid.

7. Financing is a common challenge for Kingston’s mobility system. The City budget cannot support the level of investment required to enable Kingston to reach its sustainability goals. Grants and alternative revenue streams are a vital component of any initiative.

Proposed solutions must be cost-efficient and generate sustainable revenue to cover long-term operating costs.

Kingston residents feel extremely tax burdened. Taxes have not increased in three years, and there is extreme hesitance to introducing any new tax increases.²³

Federal grant funding is a challenge for cities like Kingston. Federal projects typically require 20% local financing (or other types of matching commitments), which cities like Kingston cannot afford. Even when state and federal grants are obtained, grants are restricted to covering only partial costs of a project. For example, a grant to cover sidewalk rehabilitation did not cover other infrastructure investments associated with the project.²⁴

Grant-funded projects often experience budget overruns as costs increase between the time of application and project implementation.²⁵

The City of Kingston is below its current municipal debt limit. The 2019 adopted budget showed that only 26.2% of debt limit was being used.²⁶

Total grant receipts have increased from \$8 million to \$38 million, but funding is still insufficient for major infrastructure projects.²⁷

The State’s 2% cap on property tax increases limits growth of Kingston’s budget, which increases by roughly \$500,000 per year.²⁸

Projects that are likely to get support will have their own revenue streams. The City is particularly interested in projects with a payback period under five years.²⁹

Developing key indicators to measure and evaluate progress is a priority for any new initiatives the City is undertaking. Cost effectiveness is a key value. Investments must show a clear return.³⁰

23 Ibid.

24 Interview with City Officials, February 8, 2019.

25 Ibid.

26 “2019 Adopted Budget,” City of Kingston, accessed May 2019, https://kingston-ny.gov/filestorage/8463/8511/8654/8656/2019_AdoptedBudget.pdf.

27 Interview with City Officials, February 8, 2019.

28 Ibid.

29 Ibid.

30 Ibid.

— Mission & Values

Advancing solutions to facilitate an integrated transportation system — enabled by innovative technology — that supports sustainable, efficient, and accessible mobility for cities like Kingston, New York.

SUSTAINABILITY

The initiative contributes to a reduction in greenhouse gas emissions.

FINANCIAL VIABILITY

The initiative is cost effective and can be financed both in the short, and long-term.

SYSTEM-WIDE SYNERGY

The initiative integrates across transportation domains, complementing other initiatives to create system-wide synergies.

ACCESSIBILITY

The initiative is accessible for all residents and visitors, regardless of age, income, or physical ability.

Domain Scope and Solutions Landscape

Six transportation domains are particularly relevant to Kingston:

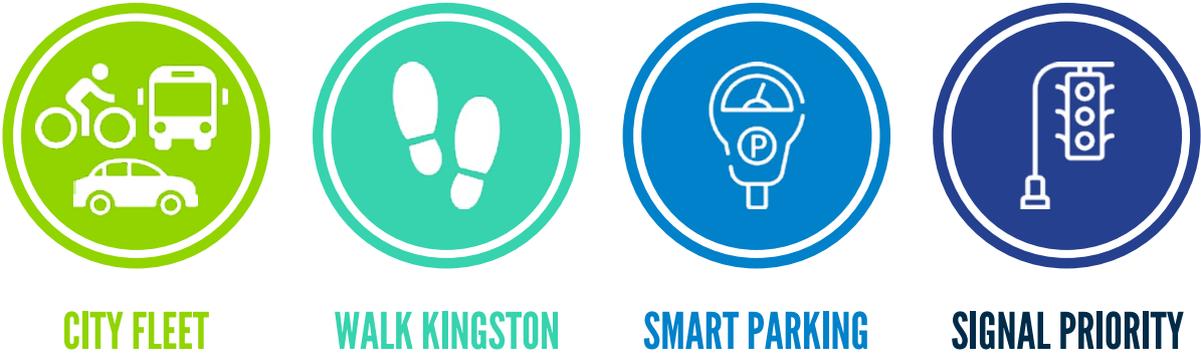
- Private Automobiles
- Public Transportation
- Streets and Traffic Signals
- Active and Micromobility
- Pedestrians
- Parking and Land Use³¹

For each domain, the team examined existing challenges and current best practices that have been implemented in cities around the world. In total, thirty potential solutions were identified across the six transportation domains (For Solutions Evaluation Matrix, refer to Appendix A).

Evaluation Matrix and Solutions Prioritization

Using our project scoring matrix, each solution was evaluated against three core values: sustainability, financial viability, and system-wide synergy. After scoring each initiative, across each value, using the positive (+1), neutral (0), negative (-1) ranking system, we developed a shortlist of the solutions with the highest total scores (For Solutions Shortlist, refer to Appendix B).

Lastly, after identifying commonalities across short-listed solutions, the solutions were organized into four initiatives:



³¹ "Shared Mobility Definitions," US Department of Transportation, accessed May 2019, <https://www.transit.dot.gov/regulations-and-guidance/shared-mobility-definitions>.



CITY



FLEET

CONTEXT

The City of Kingston needs a reliable alternative to private car ownership that aligns daily mobility with the City's long-term sustainability goals. Transportation-related emissions are currently responsible for 41% of the City's total GHG emissions.¹ In 2012, the Kingston Climate Action Plan set the goals of reducing single-occupancy vehicle use and total VMT by 20%.² To meet this goal, Kingston will need to find mobility solutions that rival the flexibility and affordability of private car-ownership. By offering on-demand access to a variety of transport modes at a low price point, a system of shared, low emissions vehicles could be a successful alternative for Kingston.

According to 2017 ACS data, 78% of Ulster County residents drive alone to work every day.³ Vehicle sharing services could improve the efficient use of vehicles and reduce the need for parking space. In addition, according to the US Department of Energy, 59.4% of all trips are less than six miles in distance.⁴ These short trips could be primary targets for shifting to shared modes.

Additionally, shared services could benefit the 39% of Kingston households who do not have private automobiles by providing affordable alternatives to traditional car ownership.⁵ In addition, a shared, multi-modal system would support the Ulster

County Transportation Council's 2040 Long-Range Transportation Plan which states:

"A key component of creating livable communities is having transportation choices available to everyone. A multimodal system that integrates walking, bicycling, transit, and automobile access is one that provides residents with more choices of where to live, work, and play."⁶

KEY FINDINGS ADDRESSED

1. **Kingston is over-reliant on automobiles as its primary mode of transportation.**
2. **Kingston's public transit system struggles to provide adequate frequency and coverage to city residents.**
3. **Kingston's size is optimal for active and micromobility solutions.**
4. **Kingston's size is optimal for active and micromobility solutions.**
5. **Parking space in Kingston's commercial districts is in short supply.**

1 City of Kingston, "Climate Action Plan," September, 2012, [https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_\(1\).pdf](https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_(1).pdf).

2 Ibid.

3 "American Community Survey, 2017," US Census Bureau, accessed 2019, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_DP03&prodType=table

4 U.S. Department of Energy, "In 2017 Nearly 60% of All Vehicle Trips were less than Six Miles," August 13, 2018, <https://www.energy.gov/eere/vehicles/articles/fotw-1042-august-13-2018-2017-nearly-60-all-vehicle-trips-were-less-six-miles>.

5 "Ulster County Coordinated Public Transit-Human Services Transportation Plan," Ulster County Transportation Council, February 2017, <https://ulstercountyny.gov/sites/default/files/documents/planning/ULSTER%20CO%20HSTCP%20Update%202016%20FINAL.pdf>

6 "Ulster County Year 2040 Long Range Transportation Plan," Ulster County Transportation Council, October 1, 2015, https://www.villageofnewpaltz.org/download/archives/sustainability_resources/ms4_resources/Ulster-County-Long-Range-Transportation-Plan-Year-2040.pdf.

PROPOSAL

City Fleet is a shared fleet of low-emissions vehicles that rivals the benefits of private car ownership. City Fleet could provide users with access to a system of public transit buses, shared electric automobiles, and dockless, pedal-assist bicycles. The fleet is managed and accessed using a software application that allows users to purchase mobility subscription packages, schedule reservations, and access vehicles.

Dockless, Pedal-Assist Bicycles

City Fleet will include access to dockless, pedal-assist bicycles. Pedal-assist bicycles are battery-powered bicycles that provide an additional boost to riders as they pedal, particularly when going uphill. Pedal-assist bikes are ideal for a shared system because their high upfront cost can be a barrier to individual ownership. In addition, the pedal-assist system can improve user comfort by reducing barriers to cycling such as fatigue or sweating on long-distance or hilly trips.⁷

In addition, data from private mobility providers indicates that pedal-assist bicycles are far more popular than traditional bicycles. For example, according to NYC's Citi Bike, "pedal-assist bikes average fourteen trips per day, while traditional bikes average only seven trips."⁸ Ithaca's operator, Lime Bike, reported similar results — stating that traditional bikes were the most financially burdensome, as opposed to the more popular and lucrative pedal-assist bikes.⁹

For a city like Kingston, choosing a dockless bike-share system will lower initial start-up costs while increasing access to valuable trip data. Individual

docks often cost between \$40,000 and \$50,000 and are often the most expensive component in a bike-share system.¹⁰ In addition, dockless systems provide more specific origin and destination data — giving system managers better resources for optimizing the shared fleet and the street system overall.¹¹ In addition, geo-fencing capability and bike lock requirements can allow system managers to set limits on where bikes can be left and how they can be parked, without requiring additional infrastructure costs.¹²

Shared Electric Vehicles

City Fleet will include a car-share program that provides members with access to electric vehicles. Users can reserve a car online, open the car with an electronic key card or Bluetooth device, and drive off. To end a reservation, the user must return the car to the designated parking spot where they first accessed it. Car-sharing could play an important role in the package of alternatives to the private automobile. Members can use transit, cycling, and walking for most of their daily trips but have access to a car when required. By equipping shared vehicles with new, super-efficient, electric motors and battery charging, this new mode of transport has the potential to make cities safer, quieter, and cleaner.

By bringing shared electric vehicles to its community, Kingston could not only optimize the use of its existing EV charging infrastructure but also provide its residents with faster, cheaper, and greener rides.

7 "The Bikeshare Planning Guide," Institute for Transportation and Development Policy, 2018, https://www.itdp.org/wp-content/uploads/2013/12/BSPG_digital.pdf.

8 Plitt, Amy, "NYC's e-bike trial run proves immensely popular with riders," Curbed, November 26, 2018, <https://ny.curbed.com/2018/11/26/18112519/nyc-citi-bike-pedal-assist-dockless-pilot>.

9 Butler, Matt, "After tense meeting, City to review Lime's e-scooter program before proceeding," Ithaca Times, October 11, 2018, https://www.ithaca.com/news/ithaca/after-tense-meeting-city-to-review-lime-s-e-scooter/article_d47333c0-cccb-11e8-99b3-532482b5dfd7.html.

10 "The Bikeshare Planning Guide."

11 "Optimizing Dockless Bikeshare for Cities," Institute for Transportation and Development Policy, May 15, 2018, <https://www.itdp.org/publication/optimizing-dockless-bikeshare-cities/>.

12 "The Bikeshare Planning Guide."

City Fleet is a shared fleet of low-emissions vehicles that rivals the benefits of private car ownership.

Public Bus Transit

City Fleet will include access to Ulster County's existing public bus system — Ulster County Area Transit (UCAT), which includes the anticipated merger of Citibus routes. As of 2017, UCAT ridership included over 400,000 annual riders, and the County already plans to transition to an all-electric vehicle fleet in 2020.¹³ City Fleet should aim to support the existing public transit system by incentivizing users to choose these modes.

Mobility-as-a-Service Software Application

At scale, all City Fleet vehicles will be available for planning, booking, and payment in a single software application. The City Fleet application will allow users to move across transit modes with a single login and monthly payment — eliminating barriers to multi-modal transport. Subscription packages could range from pay-as-you-go to unlimited rides. End-to-end Mobility-as-a-Service (MaaS) applications are only beginning to appear in the private market. Thus, as capabilities develop within existing third-party platforms (such as Uber, Lyft, or Google Maps) it may be possible to deploy a system relying significantly on private partners.¹⁴ However, off-the-shelf products are also emerging that would allow the City of Kingston to bootstrap its own MaaS system at a municipal or regional level.

¹³ "Acting County Executive Adele B. Reiter Announces Submission Of Resolution To Finalize UCAT/Citibus Integration," Ulster County, April 3, 2019, <https://ulstercountyny.gov/news/executive/acting-county-executive-adele-b-reiter-announces-submission-resolution-finalize>.

¹⁴ Goodall, Warwick, et al., "The rise of mobility as a service," Deloitte Review, 2017, <https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cb-ths-rise-of-mobility-as-a-service.pdf>.

VALUES ADDRESSED

SUSTAINABILITY

Digitalized mobility solutions, whether multimodal MaaS applications or separate services such as car-sharing and bike-sharing have the potential to reduce emissions and VMT. A 2018 report analyzed the environmental effects of multimodal mobility services using scenario modeling for five Nordic countries — Finland, Sweden, Norway, Denmark, and Iceland. Their analysis found that systems with both car-share and bike-share had the potential to reduce total CO2 emissions by 6.8% and total VMT by 10.9%.¹⁵ While these findings were modeled using mobility patterns that may not apply to Kingston, additional research supports the environmental benefits of shifting to public transit, pedal-assist bicycles, and shared electric vehicles.

Public Bus Transit

By shifting users to shared modes of transit and away from single-occupancy vehicles, public bus transit produces 33% lower GHGs per passenger mile than private vehicles. In addition, shifting to electric buses, which use 15% to 40% less fuel, further reduces emissions.¹⁶

Shared Electric Vehicles

Car-share programs decrease the number of cars on city streets, reducing congestion and improving air quality. According to one estimate, each shared vehicle reduces the need for 9 to 13 private automobiles. At the same time, the average number of VMT by car-sharing members also decreases by 26.9% to 32.9%.¹⁷ With respect to emissions, in its 2018 Impact Report, Zipcar stated that its members reduce their individual CO2 footprint by up to 1,600 pounds per year.¹⁸ By adding electric cars into a

shared fleet, car-share programs could further reduce fuel usage and air pollution.

Dockless, Pedal-Assist Bicycles

Pedal-assist bicycles produce little or no greenhouse gases or local air pollutant emissions.¹⁹ Although pedal-assist bicycles do require charging, they are still the most energy-efficient form of motorized transport, consuming the electricity equivalent of about 1,000 miles per gallon of gas.²⁰

FINANCIAL VIABILITY

As the City Fleet financial model demonstrates, City Fleet can be economically viable. The program's subscription model offers opportunities to generate substantial revenues. At a 3% adoption level, revenue estimates range from \$1.5 to \$2.8 million when deployed in Kingston and \$4.4 to \$8 million when deployed throughout Ulster County.

Operational expenses will vary depending on staffing levels, insurance coverage, and equipment maintenance but are projected to range from \$1 to \$2.7 million when deployed in Kingston, and from \$2.7 to \$6 million when deployed throughout Ulster County. In total, City Fleet is projected to generate net operating revenues ranging from \$100k to \$500k when deployed in Kingston, and from \$1.7 to \$2 million when deployed throughout Ulster County.

When looking at capital expenditures (CapEx), City Fleet's costs will vary based on the size of the fleet, and in particular, the number of new electric vehicles that are purchased. Projected CapEx ranges from \$450k to \$2.7 million when deployed in the City of Kingston, as well as an additional \$1.5 to

15 Laine, Anna, et al., "Mobility as a Service and Greener Transportation Systems in a Nordic Context," Nordic Council of Ministers, 2018, <http://norden.diva-portal.org/smash/get/diva2:1267951/FULLTEXT01.pdf>.

16 "Public Transportation's Role in Responding to Climate Change," U.S. Department of Transportation, January, 2010, <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf>.

17 Martin, Elliot, "The Impact of Carsharing on Household Vehicle Ownership," 2011, <http://reconnectingamerica.org/assets/Uploads/access38carsharingownership.pdf>.

18 "Driving Change in 2018," Zipcar, 2018, https://zipcar-drupal-prod.s3.amazonaws.com/sites/all/pdfs/Zipcar_impact_report_2018.pdf.

19 "A Global High Shift Cycling Scenario," Institute for Transportation and Development Policy, November 12, 2015, https://www.itdp.org/wp-content/uploads/2015/11/A-Global-High-Shift-Cycling-Scenario_Nov-2015.pdf.

20 Thompson, Heather, "As Transportation Costs, Emissions Grow, Electric Bikes Offer An Efficient Alternative," Forbes, July 6, 2017, <https://www.forbes.com/sites/energyinnovation/2017/07/06/as-transportation-costs-emissions-grow-electric-bikes-offer-an-efficient-alternative/#67f7da59305a>.

\$5.6 million when the system is expanded across Ulster County. While City Fleet’s revenues would be sufficient to cover long-term operating costs, with a payback period of eight to twelve years (not including financing costs), the City would likely need subsidies to finance the program’s capital costs (For City Fleet Financial Model, refer to Appendix C).

ACCESSIBILITY

Access for those with disabilities

Unlike other public transit modes, which must meet government standards for disability access, shared systems are not initially designed to these standards. However, both car and bike-share systems have implemented solutions to meet these needs. For example, numerous car-share services offer mobility devices for disabled customers including hand controls, spinner knobs, and pedal extenders, which can be made available upon request.²¹ Similarly, numerous cities have explored options to include adaptive bicycles in their fleet including handcycles, tricycles, or tandems.²² In addition, pedal-assist bicycles are shown to benefit the elderly population, by reducing the workload required by a traditional bike.²³

Access for those with limited English proficiency

All software applications and marketing materials should be made available in languages used by residents in the population area. For the City of Kingston, this should include Spanish translations — as of 2017, 9.4% of Kingston’s population speaks Spanish.²⁴

Access considerations for low-income or low-tech users

Accessibility to shared systems can be limited by the need for a smartphone to locate and unlock vehicles and a credit card to pay for reservations.

City Fleet should provide at least one alternative payment option (phone access, prepaid cards, etc.). For example, PayNearMe is a service that allows users to pay with cash at local retailers.²⁵ In addition, reduced-fare plans should be made available to low-income customers.

Equitable fleet distribution

To ensure that all parts of the service area have access to vehicles, the operator should establish and enforce minimum service levels in every neighborhood zone. If a zone falls below its minimum level, system rebalancing would be triggered to facilitate continued access. This could ensure that vehicles are equitably distributed and can be reliably accessed in low-demand areas.

SYSTEM-WIDE SYNERGY

In addition to sustainability and accessibility, City Fleet will have positive spillover effects on Kingston’s entire transportation system. City Fleet will reduce the demand for parking and shorten the search for parking by moving more people to buses and bicycles and ensuring that car-share members have reserved space — lowering the number of cars competing for the curb. When combined with smart infrastructure, City Fleet produces additional synergies. By communicating with traffic signals to receive Transit Signal Priority, UCAT buses will improve levels of service by increasing on-time arrivals and reducing travel times. In addition, moving people out of private cars will increase pedestrian trips, creating a lively street atmosphere. By providing access to multiple transit modes, City Fleet could be a model for other small cities for shifting transportation from private, single-occupancy vehicles toward shared or active transit modes.

21 Enterprise Carshare; Zipcar, “Customers with disabilities,” <https://www.enterprise-carshare.com/us/en/customers-with-disabilities.html>; <https://support.zipcar.com/hc/en-us/articles/360001630448-What-services-are-available-for-disabled-members->

22 “The Bikeshare Planning Guide,” Institute for Transportation and Development Policy, 2018, https://www.itdp.org/wp-content/uploads/2013/12/BSPG_digital.pdf

23 Jones, T. et al. “Cycle Boom: Design for Lifelong Health and Wellbeing,” Oxford Brookes University, UK., 2016, <https://d1qmdf3vop2l07.cloudfront.net/quaint-manatee.cloudvent.net/compressed/5ab7ab985c867240c4f1883d77e0fbb1.pdf>; Johnson, Marilyn, “Extending life on the bike: Electric bike use by older Australians,” June 2015, <https://research.monash.edu/en/publications/extending-life-on-the-bike-electric-bike-use-by-older-australians>

24 American Community Survey 2017, US Census Bureau, accessed 2019, <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF>.

25 “Shared mobility pilot program request for applications e-bikes,” Jump, July 27, 2018, <https://www.smgov.net/uploadedFiles/Departments/PCD/Transportation/JUMP%20Bikes.pdf>.

CASE STUDIES

UbiGo: Gothenburg, Sweden

Swedish company UbiGo launched an initial pilot of its mobility services in 2013 in Gothenburg, Sweden. For six months, seventy households agreed to hand over their private cars in exchange for access to UbiGo's integrated mobility service app which included public transit, car-share, car rental, taxi, and bike-share in a single application, with a single payment and 24/7 customer service. Users could design specific service packages to meet their household needs and pay out of pocket for subscriptions. Unused amounts were rolled over to the following month, and subscribers could also purchase additional service credits on-the-go. A built-in incentive program rewarded users with redeemable bonus points for taking environmentally friendly modes. At the end of the pilot, 97% of participants wanted to keep using UbiGo.²⁶ UbiGo then expanded its pilot to Stockholm and announced plans to launch full services in 2018.²⁷

MaaS Global: Helsinki, Finland

MaaS Global launched the Whim Mobility-as-a-Service application in Helsinki, Finland in 2015. As of 2018, Whim has expanded to operate in West Midlands, UK and Antwerp, Belgium. Using the Whim software application, users can plan and book trips across the city's public transit system and private bike-share, taxi, car-share, and car rental systems. Whim offers a variety of subscription packages ranging from unlimited access to pay-as-you go. Whim negotiates pricing with individual mobility providers before integrating their services into the app. Whim is the product of Finland's Act of Transport Services which requires all transportation providers to make data accessible via an open interface.²⁸

²⁶ Sochor, Jana, "Travelers' motives for adopting a new, innovative travel service: insights from the UbiGo field operational test in Gothenburg, Sweden," Chalmers University of Technology, September 7, 2014, <https://core.ac.uk/download/pdf/70608560.pdf>.

²⁷ Jacobs, Frank, "UbiGo (re)launches MaaS project in Stockholm," FleetEurope, October 17, 2017, <https://www.fleeturope.com/en/smart-mobility//article/ubigo-relaunches-maas-project-stockholm?a=FJA05&t%5B0%5D=UbiGo&t%5B1%5D=Fluidhub&curl=1>.

²⁸ Zipper, David, "Helsinki's MaaS App, Whim: Is It Really Mobility's Great Hope?" CityLab, October 25, 2018, <https://www.citylab.com/perspective/2018/10/helsinki-maas-app-whim-is-it-really-mobilitys-great-hope/573841/>.

Buffalo CarShare

In Buffalo, New York, Buffalo CarShare (BCS) began operations in June 2009 with four vehicles and thirty pioneering members. By 2011, the organization grew to over 400 members and eleven vehicles. Members made 8,600 trips totaling 32,000 hours and 241,000 miles through August 2011. Based on results of member surveys conducted in the spring of 2010 and summer of 2011, BCS helped take 109 private cars off the road, and its members avoided using 24,359 gallons of gas and eliminated 500,000 VMT. Unique to the industry, BCS has achieved these environmental accomplishments while serving a diverse membership base in terms of age, race, and income. Nearly two thirds of its members represent households earning \$35,000 or less, and half report incomes of less than \$25,000.²⁹

However, in June 2015, this non-profit car sharing program ceased operations after its insurance company, Philadelphia Insurance, ended its coverage. At the time of its shutdown, Buffalo CarShare had 900 individual, small business, and nonprofit members sharing a fleet of nineteen cars, trucks, and vans.³⁰ Philadelphia Insurance's decision was due, in part, to the fact that the insurance company didn't reach profit goals due to state insurance laws. In New York, personal injury protection law, commonly referred to as no-fault, states that when a person gets into an accident, regardless of whose fault it is, the insurance carrier pays for medical bills.³¹

The City of Philadelphia & Berkeley, California

The cities of Philadelphia, PA and Berkeley, CA, provide two early examples of municipal governments incorporating car sharing programs into their fleets. In 2004, the City of Philadelphia eliminated more than 300 municipal vehicles with a net savings of approximately \$9 million over a five-year period, including reduced costs for acquisition, parking, vehicle maintenance, and fuel.³² In the same year, the City of Berkeley replaced fifteen underused fleet cars with five car sharing vehicles, yielding approximately \$400,000 in savings over three years — \$250,000 in the replacement of cars, gasoline, and maintenance and \$150,000 on insurance and fleet management.³³

29 "Buffalo CarShare: Two Years in Review," New York State Department of Transportation, November 2011, <https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-08-24%20Buffalo%20CarShare%20Final%20Report.pdf>.

30 Drury, Tracey, "Buffalo CarShare to be acquired by Zipcar," Buffalo Business First, September 30, 2015, https://www.bizjournals.com/buffalo/blog/morning_roundup/2015/09/buffalo-carshare-to-be-acquired-by-zipcar.html.

31 Johnson, Cat, "Buffalo CarShare Ceases Operation Due to New York Insurance Law," June 23, 2015, <https://www.shareable.net/blog/buffalo-carshare-ceases-operation-due-to-new-york-insurance-law>.

32 www.phillycarshare.org/tiny_mce/filemanager/files/2006/2006.12_government_finance_review_an_exercise_in_cost_saving_car_sharing.pdf.

33 Cohen, Adam, et al. "Carsharing: A Guide for Local Planners," May 2008, http://www.carsharing.org/wp/research/TSRC/Guide_for_Planners.pdf.

P I L O T

An initial City Fleet pilot will deploy a minimal multi-modal fleet that allows the City to test operating assumptions and verify consumer demand while limiting cost and risk. The pilot will provide subscribers with access to 1.) a dockless fleet of pedal-assist bicycles, 2.) a car-share system utilizing existing municipal vehicles, and 3.) a UCAT monthly pass.

Rather than deploying a full shared electric vehicle fleet, the City could lower costs by adapting its existing municipal light duty electric fleet to operate as a shared vehicle fleet during off-peak periods. Most car-sharing services experience peak demand on evenings and weekends, whereas municipal usage is likely to be highest during the working day. Currently, the City of Kingston owns seven electric vehicles, including four Chevy Volts and three Nissan Leafs. By increasing usage of these vehicles, the City will increase the utilization of the fleet itself and the newly installed EV charging infrastructure.

The most expensive component of the City Fleet pilot is the shared, dockless, pedal-assist bicycle fleet, which requires the City to procure new vehicles and hire operational staff — unless private operators can be procured. In addition, developing a software application to unite all modes could raise pilot costs. Instead, the City Fleet pilot should utilize off-the-shelf software platforms to deploy and manage the pilot. A successful solution would offer a simple user interface that allows for trip planning, booking, and payment processing, as well as back end tools for fleet management and optimization.

IMPLEMENTATION PLAN

1. Establish an Operating Department

Lead Agency: Implementing Agency

The pilot's Implementing Agency should build an operating department responsible for the system's day-to-day operations including fleet charging, rebalancing, maintenance, customer service, and public engagement. There are three primary operating models to consider. City Fleet could issue operating contracts to a single private operator; multiple private operators; or, could build internal capacity to publicly operate the system.

Given the City of Kingston's past difficulty procuring a car-share provider, we anticipate that City Fleet may be unable to procure private operators that meet the City's requirements, and thus would be required to establish a publicly-owned and operated system.

A recommended staffing plan would include:

- 1 Program Director: main point of contact for all system planning, design, procurement, and City-related communications
- 2 Program Coordinators: ensure fleet runs smoothly — one coordinator responsible for scheduling and overseeing mechanics and re-balancing system; one coordinator responsible for customer service and marketing
- 2 Full-Time Fleet Managers per 100 vehicles (bikes and automobiles): responsible for maintenance, repair, and rebalancing
- 3 Part-Time Fleet Managers per 100 vehicles: responsible for maintenance, repair, and rebalancing

2. Define the Coverage Area

Lead Agency: Implementing Agency

The Implementing Agency will need to define the boundaries of the service coverage area for all vehicle types. In most cases, users will not be able to end a trip until the vehicle is returned to the service area, which is identified through geo-fencing. Thus, the Implementing Agency may want to consider collaborations with other cities in Ulster County to increase the service area beyond Kingston city limits. For example, if a user were to bike to Walmart in the Town of Ulster, they would continue paying for their trip until the vehicle returned to Kingston city limits.

3. Define Target Locations

Lead Agency: Implementing Agency and Operating Department

The Implementing Agency will need to develop a service policy that determines how many vehicles will be available in each zone or neighborhood within the service area. The policy should create an equitable distribution of vehicles while a.) targeting populations that are more likely to use the service (for example: high concentrations of users under age 40, with incomes under \$75,000 are often early adopters) and b.) identifying locations that are ideal for mode-shifts including bus stops, commuter stations, and popular retail destinations. Location service policy should be iterative and revisited regularly to best meet demand.

4. Determine Pricing Structure

Lead Agency: Implementing Agency and Operating Department

The Implementing Agency and Operating Department will cooperate to develop pricing structures for the City Fleet system (view financial model proposal for estimates). The pricing structure should include negotiations with UCAT to include monthly UCAT passes in the subscription package. Pricing considerations will include application fees, tiered pricing models, monthly or annual membership fees, pay-as-you-go fees, hourly reservation rates, or incremental mileage charges. The Implementing Agency will also consider equity or accessibility goals such as providing discounts for low-income residents, students, or seniors.

5. Pass Municipal Ordinances Necessary to Operate System

Lead Agency: Implementing Agency and City Corporation Counsel

A legal review should be conducted to determine what municipal ordinances may be needed to operate the shared fleet system. For example, the City of New York passed an ordinance that classified pedal-assist bicycles as Class 1 vehicles to secure their legal use. Additional ordinances may be needed to allow municipal vehicles to be driven by non-municipal employees.

6. Establish Data Privacy Policy

Lead Agency: Implementing Agency and City Corporation Counsel

All data collected by City Fleet should be collected and stored in a manner that complies with established legislation on privacy and data security. To protect user data, mechanisms should be put in place to anonymize and aggregate bike-share user data to minimize the potential to identify individual users based on their usage habits. The Implementing Agency should also consider how to communicate its data policy so that users understand what data is being collected and how it is being used.

7. Procure All Hardware and Software Components

Lead Agency: Implementing Agency and Operating Department

The Implementing Agency and Operating Department should collaborate to define technical requirements for all fleet hardware and software components and to procure components that meet or exceed requirements.

8. Procure All Operational and Regulatory Components

Lead Agency: Implementing Agency and Operating Department

The Implementing Agency and Operating Department should collaborate to define technical requirements for all operational and regulatory components and to procure components that meet or exceed requirements.

9. Set Hours of Operation and Maintenance Schedule

Lead Agency: Operating Department

The Operating Department will need to develop a plan for hourly operations, including fleet hours of availability, inspection and maintenance schedules, re-balancing schedules, charging schedules, and customer service operations.

10. Deploy Branding, Marketing, and Public Engagement Strategy

Lead Agency: Implementing Agency

Prior to the system's launch the City will need to develop a public engagement strategy to educate consumers, ignite interest, and prepare drivers. The City should also develop a media strategy that would raise attention for the system's launch.

For example, electric vehicle demonstrations can be helpful to increase the acceptance and deployment of electric car-share. Data and feedback provided by visitors could be relayed to the Implementing Agency and Operating Department to elicit more specific and strategic promotional initiatives that directly address the concerns of Kingston residents and other potential users.

11. Recruit Pilot Participants

Lead Agency: Operating Department

In order to create demand for City Fleet, the Implementing Agency should recruit households to commit to using the City Fleet system for six months. Costs could be subsidized for the length of the pilot to incentivize participation. Securing early participants will give the Implementing Agency an opportunity to collect user feedback and better understand service needs.

12. Launch System and Collect Performance Data to Improve Operating Strategy

Lead Agency: Operating Department

After initial system launch, the Operating Department will be responsible for tracking performance and adjusting operating policies to improve performance. The Implementing Agency may issue specific quarterly or annual reporting requirements to track the system's effectiveness.

— Key Performance Indicators

RIDERSHIP AND OPERATIONAL SUSTAINABILITY

Uptake rate: the percentage of individuals within the coverage area that use the City Fleet system. System goals are often set at 3%, 6% and 9%.

Vehicle turnover: the numbers of rides per vehicles per day.

Revenue per vehicle per month

EMISSIONS REDUCTIONS

Reduction in GHGs: Emissions reductions as a result of modal shift can be conducted using the Transport Emissions Evaluation Model for Projects (TEEMP), developed by the Clean Air Asia partnership, which allows for measurement of CO₂ (and other) impacts of transportation interventions compared to the “business-as-usual” scenario. The Implementing Agency should collect the data necessary to run the TEEMP model annually to quantify the environmental benefits of the system.

Reduction in VMT: Net change in annual vehicle miles traveled in private vehicles.

COMMUNITY ENGAGEMENT

Increase in road safety: reduction in total vehicle collisions and number of injuries related to the shared fleet. To evaluate cyclist safety in particular, further evaluation could include the total number of cyclists killed or seriously injured (KSI) in years prior to the system launch compared to after the launch, as well as comparing these numbers inside and outside of the bike-share service area.

Member satisfaction: improved satisfaction and perception of increased mobility among residents based on member surveys.

FINANCIAL MODEL

A scenario-based financial model was developed to assess the economic feasibility of City Fleet. The full model is available in Appendix C.

The model includes three scenarios, each with the following key assumptions:

	Bikes per 1,000 Residents	New Electric Vehicle Purchases	Average Subscription Price
LOW	10	0	\$150
MEDIUM	20	5	\$200
HIGH	30	10	\$300

In the **LOW** scenario, all component costs were measured at the low-end; in the **HIGH** scenario, all component costs were measured at the high-end; in the **MEDIUM** scenario, all component costs were measured as the average of the low and high-end costs.

The following tables provide descriptions of all components costs and estimates of potential revenues for the City Fleet system.

HARDWARE COSTS

Dockless, Pedal-Assist Bike Fleet

ITEM	REQUIREMENTS	COST RANGE
Pedal-Assist E-Bikes	<p>Fleet Size: 10-30 bikes per 1,000 residents, plus an additional 20% increase for fleet in reserve for maintenance, rebalancing, and charging *Assume 2 to 10% vandalism and theft per month</p> <p>Known Providers: Storybike, Rad Power Bikes</p>	\$1,500 to \$2,000 per unit
IoT Device	<p>Transmits GPS location, battery level, trip origin and destination Must be 3G compatible or higher May include other sensors for cut wires, theft alert, etc.</p> <p>Known Providers: Omni, AXA, Linka</p>	\$50 to \$130 per unit
SmartLock	<p>City could choose to require locks that connect to infrastructure to promote proper parking, such as a U-lock or retractable cable lock. Some SmartLocks contain the IoT device as well, which could decrease costs depending on requirements.</p> <p>Known Providers: Bitlock, Linka, AXA</p>	\$120 to \$200 per unit

Electric Vehicle Fleet Components

ITEM	REQUIREMENTS	COST RANGE
Electric Vehicles	<p>Fleet Size: Nine electric vehicles in municipal fleet</p>	<p>No plan to procure additional vehicles in pilot phase. If purchasing additional EV:</p> <p>Battery Electric Vehicle with a 150-mile range: \$50,000 to \$74,000 in 2018³⁴</p>
Entry and Ignition Systems and IoT Device	<p>Smartphone as the digital key to unlock the car remotely for a seamless check-in or issue key cards to unlock/lock the car and track usage. Car reader attached to the windshield of the vehicle.</p> <p>GPS Unit for tracking key metrics: location, battery level, mileage</p> <p>Known Providers: Local Motion (by Zipcar), PoolCar, OpenCar Networks, Inc.</p>	<p>Upfront expenses run \$1,000 to \$1,700 per vehicle</p>

34 Lutsey, Nic and Michael Nicholas, "Update on electric vehicle costs in the United States through 2030," The International Council on Clean Transportation, April 2, 2019, https://www.theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

SOFTWARE COSTS

ITEM	REQUIREMENTS	COST RANGE
Mobile App	<p><i>System Requirements:</i> iOS and Android compatible Multimodality: can be used on a variety of vehicles (bikes, automobiles, scooters, etc.) and with a variety of manufacturers</p> <p><i>Front End Requirements:</i> Maintain user profiles Purchase subscriptions Offer on-demand access and advance reservation Locate and unlock vehicles Access to customer support and collision reporting Intuitive and easy to use</p> <p><i>Back End Requirements:</i> Data format should meet formatting standards set by the Mobility Data Specification (MDS) Vehicle data and flagging based on conditions such as needing charging, rebalancing, maintenance, or missing vehicles User and ride data: who is using the vehicle, trip time and duration, trip origin, destination, and route; collision reporting Payment processing gateway Open API to allow for customization and data integration</p> <p><i>Optional Requirements:</i> Ability to offer promotions Ability to offer in-app third-party advertising for additional revenue</p> <p>Known Providers: JoyRide, 8D Technologies, Noa Technologies, Linka FleetView, FluidTime, GetAround, Maven, Rent Centric, Metavera Solutions, Inc.</p>	<p>Implementation Fee: \$8,000</p> <p>Operating Fee: \$15 to \$50 per bicycle, per month \$40 to \$60 per automobile per month</p>
Data Plan	Data plan required for IoT Devices, roughly 35 to 50 mgb per month per vehicle	\$5 to \$20 per vehicle

OPERATING COSTS

ITEM	REQUIREMENTS	COST RANGE
Staff Salaries	<p>Recommended operating staff:</p> <p>1 Program Director 2 Program Coordinators 2 Full-Time Fleet Managers per 100 vehicles (bikes + autos) 3 Part-Time Fleet Managers per 100 vehicles (bikes + autos)</p>	Staffing costs were estimated using City of Kingston 2019 Adopted budget as a benchmark ³⁵
Trucks	<p>Small box trucks for collecting and transporting vehicles</p> <p>System requires 2 trucks per 100 bicycles</p>	\$25,000 to \$40,000
Maintenance Facility	<p>Facility for charging and fleet maintenance</p> <p>Requires special outfitting and wiring for charging facilities</p> <p>Roughly 3,000 sqft per 250 vehicles</p>	\$5 to \$10 per square foot annually
Electricity	Charging capabilities for vehicles	20.4 cents/kWh (multiply by charge time per vehicle)
Insurance Policy	<p>Commercial General Liability Policy for \$1 million in coverage</p> <p>Optional: 1st Party Coverage for fleet damage/theft</p>	<p>For EVs: \$90 per car, per month³⁶</p> <p>Estimate cost range: \$10,000 to \$20,000</p>
EV Pick Up/Drop Off Locations	Designated parking space/docking station for the shared cars located around existing EV charging stations	
EV Charging	Charging capabilities for vehicles	Electric Vehicle battery pack cost ranges from \$130/kWh to \$191/kWh
UCAT Subscriptions	The City Fleet System will need to negotiate rates with UCAT to include bus access for subscribers; if the shared system orders passes in bulk it may be able to receive additional discounts.	\$65 for monthly pass, potential to negotiate lower price points if subscriptions purchased in bulk

35 "2019 Adopted Budget," City of Kingston, accessed May 2019, https://kingston-ny.gov/filestorage/8463/8511/8654/8656/2019_AdoptedBudget.pdf.

36 Interview with Ithaca Carshare, May 7, 2019.

POTENTIAL REVENUES

ITEM	DESCRIPTION	REVENUE RANGE
Membership Subscriptions	<p>Both monthly and annual membership subscriptions can be sold to City Fleet users. Subscription packages can be tailored to meet a variety of user needs, potential packages could include:</p> <p>Unlimited access to all system modes</p> <p>Unlimited access to bus and bike-share, limited access to car-share.</p> <p>Unlimited access to bus, limited access to bike-share</p> <p>Subscriptions should include reduced prices for qualifying low-income users.</p> <p>Subscription prices can be altered to accommodate various trip lengths. Passes for 60 minute bike trips could be priced higher than 30 minute trips. Passes with 24hr car reservations could be priced higher than packages with hourly car reservations.</p> <p>Subscriptions may include usage fees for as-needed trips that exceed coverage.</p>	<p>Monthly bike-share subscriptions range from \$10 to \$30 per month, and \$5 for low-income users.</p> <p>Annual bike-share subscriptions range from \$70 to \$169.</p> <p>Both monthly and annual bike-share prices would likely be higher for an all-pedal-assist fleet. As of April 2019, Jump offered a \$30 monthly package in some cities that gave users 60 minutes per day, then \$0.10 per minute after that.³⁷</p> <p>Monthly car-share subscriptions range from \$199 to \$375.</p> <p>The UCAT public transit system currently offers unlimited monthly passes for \$65.</p>
Pay-Per-Trip Usage Fees	<p>For users who do not purchase subscriptions, usage fees can charge users per trip, per mile traveled, or per unit of time.</p> <p>Per trip pricing may serve to lower barriers to accessing bike-share for some groups that may not be able to make a more costly investment in a monthly or annual membership.</p> <p>Per trip fees could also include daily rental rates.</p>	<p>Bike and scooter system usage fees: Lyft and Bird scooters charge \$1 to unlock vehicle and \$0.15 per minute. Lime charges \$1 to unlock vehicle and \$0.05 per minute. Jump bikes rental prices vary by city but are often free to unlock and \$0.15 per minute. Citi Bike charges \$3 for a 30 minute ride or \$12 for a day pass.</p> <p>Car-share usage fees: Zipcar in New York has standard hourly rates starting at \$10 for 180 miles per day. Maven charges hourly rates starting at \$8 plus applicable taxes for electric vehicles. Enterprise car-share's hourly rate starts at \$8 for New York Metro, with daily rates for \$69 with a 200 mile limit. Car2go charges \$ 0.41 per minute, \$15 per hour, or \$89 per day.</p> <p>The UCAT public transit single rides fare is \$1.50 for rides within Ulster County or \$2 outside Ulster County.</p>

POTENTIAL REVENUES

<p>Advertising and Sponsorship Revenues</p>	<p>Shared fleets have numerous opportunities to sell space to advertisers. The vehicles themselves could be branded to identify system sponsors, and the mobile app could include advertising space.</p>	<p>Estimate cost range: \$10,000 to \$30,000</p>
<p>Application Fees</p>	<p>For users enrolling in car-share programs, additional fees could be charged to cover application processing costs.</p>	<p>Zipcar has a \$25 sign up fee Car2go has a \$5 sign up fee GetAround charges 3% of the trip price as a booking fee</p>
<p>Trip Data Revenues</p>	<p>Shared fleets generate significant data related to user travel behavior. De-identified user trip data would likely be valuable to marketers, advertisers, or other private sector firms. However, any potential revenues from user data must comply with existing data use policies.</p>	<p>Unknown, not included in financial model</p>



**WALK
KINGSTON**

CONTEXT

Kingston is a small city with a high population density. Despite the city’s close-knit grid of residential and commercial areas, many residents still choose to take automobiles to destinations that could be reached on-foot. Barriers that prevent Kingstonians from choosing to walk include, steep hills, aging and unsafe sidewalks, and a general culture of ignoring walking as a viable transportation mode.

However, the City of Kingston has cast a strong vision to improve the City’s walkability. Kingston’s 2025 Comprehensive Plan set the objective to:

“Transform all city streets into ‘Complete Streets’ inclusive of pedestrians, cyclists, and on-street parking, prioritizing vital connections, such as Safe Routes to Schools, easy access from neighborhoods to commercial areas, and linking together existing and future multi-use trails and parks/recreation facilities.”¹ In addition, Kingston is concentrating its resources into building infrastructure capacity for non-motorized transportation.

Walk Kingston aligns with this objective to promote active traveling through human-powered transportation. The Walk Kingston initiative aims to increase pedestrian activity in Kingston by igniting a social culture that promotes non-motorized transportation, raising awareness of public health benefits, fostering economic activity for vendors and local retailers, and encouraging social interaction in Kingston’s public spaces.

KEY FINDINGS ADDRESSED

3. Despite its small size, Kingston is not as walkable as it could be.
4. Kingston’s size is optimal for active and micromobility solutions.

¹ Shuster-Turner - Planning Consultants” Kingston 2025, City of Kingston, NY, Comprehensive Plan,” The Kingston City of Council, March 15, 2016 https://www.kingston-ny.gov/filestorage/8463/10953/13539/Kingston_2025_Adopted_Version.pdf.

PROPOSAL

Aligned with Kingston City Council's ongoing project to build infrastructure for pedestrians and cyclists, we recommend two solutions to improve pedestrian activity. First, we recommend Car-Free Sunday, a program that creates a temporary pedestrian priority zone to mobilize walking and cycling activities. Second, we propose a digital gamification platform which encourages sustainable modes of transportation. Together, these two solutions aim to create a cultural shift among pedestrians and cyclists and nudge them to change their transit choices towards more sustainable modes.

Car-Free Sunday

Car-Free Sunday temporarily closes streets to automobile activity and instead gives priority to pedestrians and cyclists. This initiative has already been executed over cities around the world. In successful cases, initial programs have been geographically expanded within a city. According to a report, 'The Open Streets Guide,' in North America, 70 pedestrian zone programs have been implemented, and 28% of participating cities have a population of less than 100,000. 52% of programs are funded through public-private partnerships. On average, pedestrian zones are 3.95 miles in length, and 73% of projects contain elements of social, play, wellness, and educational activities.²

The City of Kingston has promoted several parks and riverside areas where people interact and engage in outdoor activities. However, the existing programs are focused on educational and social activities rather than boosting walkability.

Car-Free Sunday creates exposure to sustainable mobility and fosters a culture of community health. Car-Free Sunday could be located in the center of the city, where there is high accessibility, a strong retail presence, and smooth connections to public transit.

Gamification

Gamification is a programming concept that uses social competition and entertainment to change users' behavior, and eventually, transform their lifestyle. When applied to a transportation system, gamification can encourage users to choose more sustainable modes of travel. For example, if participants adjust their behavior, they collect points that can be redeemed for monetary or non-monetary rewards and incentives. A Walk Kingston digital platform could be built as a separate smartphone application or website, or could be integrated into the City's existing platforms. Rewards and incentives can be varied to target audiences' needs. While students might receive stickers, adults could receive discounts at local businesses.

For populations who may not be familiar with using smartphones, electronic cards can provide an alternative (ex: Case 3 "Beat The Street"). Participants receive cards in public libraries and government offices, and as they walk or ride bikes, they can tap the cards on devices installed throughout the city to collect redeemable credits.

² The Alliance for Biking & Walking and The Street Plans Collaborative, "The Open Street Guide," 2012 https://nacto.org/docs/usdg/smaller_open_streets_guide_final_print_alliance_biking_walking.pdf

VALUES ADDRESSED

SUSTAINABILITY

Car-Free Sunday and a digital gamification platform promote the original zero-emission transportation mode — walking. Facilitating voluntary public engagement in active traveling over motorized transportation can reduce GHGs. According to a study of transportation patterns in Cardiff, Wales, walking or cycling could viably replace roughly 41% of all short car trips (less than 3 miles), and in doing so, could reduce 5% of total vehicle-related GHGs.³ While mobility patterns will differ between cities, the same methodology can be applied to measure the emissions reduction potential for Kingston.

FINANCIAL VIABILITY

Car-Free Sunday is a low-cost initiative that can be deployed quickly. Operating expenses will vary depending on scale, staffing levels, and programming — as well as the frequency of the event overall. Hiring police officers is the initiative's largest operational expense, as officers are needed to re-route automobile traffic and provide security. If 0.5 miles to 2 miles of streets are closed, the average cost for human resources is roughly \$5,700 per week. In many cases, public-private partnerships are formed to recruit sponsorships from corporations, health care companies, and financial institutions in order to offset operating costs.⁴

Expenses for implementing a digital gamification platform will vary depending on how it is designed. Using an existing software application is significantly quicker and more cost effective than building a new application. In addition, costs will vary depending on the types of incentives that are offered to participants. While incentives must be substantial enough to promote participation, we do not recommend direct monetary incentives as the program is not structured to generate revenue.

ACCESSIBILITY

Car-Free Sunday should be located in an area where residents have easy access by foot. During Car-Free Sunday, activities could not only be designed to promote economic activity, but also to encourage equal participation from all Kingston residents, including older adults, children, those with disabilities, or low-income households. The weekly event could provide a regular venue for the City and other local nonprofits to provide a variety of public services.

A digital gamification platform will largely rely on smartphone access. However, an alternative platform, like an electronic card or even a physical punch card, can help provide access to low-income families and the elderly.

For both initiatives, marketing materials should be developed in both English and Spanish to provide access for non-English speakers.

SYSTEM-WIDE SYNERGY

By promoting pedestrian activity, the Walk Kingston initiative aims to support a larger shift towards active transportation and away from private automobiles — particularly for short trips within the city limits. Decreasing car use contributes to lowered congestion, more parking spots, more street space, and an increase in pedestrian safety.

³ Andre Neves, Christian Brand, "Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach," Environmental Change Institute, University of Oxford, August 31, 2018.

⁴ Shuster-Turner - Planning Consultants, "Kingston 2025, City of Kingston, NY, Comprehensive Plan," The Kingston City of Council, March 15, 2016, https://www.kingston-ny.gov/filestorage/8463/10953/13539/Kingston_2025_Adopted_Version.pdf.

CASE STUDIES

Paris Respire: Paris, France

As part of a policy to improve the quality of the air and create quieter public spaces, the City of Paris set up a system that offers pedestrian and cyclist areas in lanes freed from motorized traffic, on weekends and holidays. Since July 2017, Paris Respire has expanded all over the city. While some pedestrian priority zones only operate in the summertime or on weekends, others have become permanently closed to vehicles.⁵

Miles: Sacramento, California

In 2018, the City of Sacramento (whose population is roughly 2.5x larger than Kingston's) initiated a pilot project with the app Miles. Miles incentivizes sustainability by giving rewards for every mode of travel. The more sustainable mode of transportation a user takes, the bigger the reward the user receives. The users collect points and redeem them for products and services from

retailers in their local communities. Within nine months, participants redeemed a total of \$800,000 in rewards.⁶

Beat the Street: Sandwell, UK

The Sandwell District in the United Kingdom has operated Beat the Street since 2015. The program is designed to enhance people's health and encourage physical activity. Beat the Street turns the whole town into a game where people earn points as they walk, cycle, and run around — tapping electronic cards on Beat Boxes placed on lamp posts and other street furniture as they move throughout the city.⁷ The 'Beat card' is distributed in libraries and leisure centers. Google maps shows the locations of Beat Boxes and distribution spots.⁸ In 2016, more than 300,000 people participated, and in particular, elderly participation was notably high. Beat the Street used 500 Euro sports and fitness vouchers as its primary rewards. Surveys showed that over 80% of respondents thought Beat the Street helped them be more active, walk more than usual, and feel healthier.⁹

5 The Paris.fr Website, accessed May 2019, <https://www.paris.fr/parisrespire>.

6 Sean O'Kane, "Miles is an app that tracks your every move in exchange for deals and discounts," The Verge, July 24, 2018, <https://www.theverge.com/2018/7/24/17604438/miles-app-tracking-transportation-deals-discounts>.

7 Beat The Streets Website, accessed May 2019, <https://www.beatthestreet.me/UserPortal/Default>.

8 Google Maps of East Northamptonshire BTS, accessed May 2019, https://www.google.com/maps/d/viewer?mid=1qD-QO1UgeZEppqosqBcfqCXpzuBGVfx_P&ll=52.33953298884601%2C-0.5728932500001065&z=12.

9 "Best foot forward for Reading as Beat the Street returns!" Intelligent Health Ltd, accessed May 2019, <http://www.intelligenthealth.co.uk/best-foot-forward-for-reading-as-beat-the-street-returns/>.

IMPLEMENTATION PLAN: CAR-FREE SUNDAY

1. Select an Operating Model

Lead Agency: Department of Health and Wellness

The Operating Department will determine how to operate and fund the initiative. According to a report, The Open Streets Guide, there are six ways to implement street closure programs:

- Non-Profit Led, Privately Funded
- Publicly/Non-Profit Led, Privately Funded
- Publicly Led, Public/Privately Funded
- Non-Profit Led, Public/Privately Funded
- Publicly/Privately Led, Privately Funded
- Publicly/Privately Led, Publicly/Privately Funded.¹⁰

Based on its available resources, we recommend that Kingston adopt a Publicly Led, Public/Private Funded model in the initial stage and adopt a Publicly/Non-Profit Led, Privately Funded model in the long-run.

2. Set a Time and Location

Lead Agency: Department of Health and Wellness

The Operating Department will choose an area considering its connection to transit, neighborhood types, district route type, path route types, ancillary route types, and Kingstonians lifestyles within in communities. Ideal locations would be in the Stockade District or alongside Broadway. The initiative can have flexible times: either weekly, monthly, or seasonally. It is optimal for Kingston to hold the program on the first Sunday of the month to provide consistency for participants.

3. Organize Marketing and Programming

Lead Agency: Department of Health and Wellness and Department of Parks and Recreation

The Operating Department should organize activities that engage the public and meet local interest. Existing outdoor activities hosted by the Parks and Rec Department can also be integrated. A marketing campaign should be designed to promote the event and could highlight city government activities, such as biking with the Mayor. The City should also design a map that highlights pedestrian areas for residents and tourists.

4. Organize Event Staffing

Lead Agency: Police Department and Department of Health and Wellness

The Operating Department should work with Police to deploy staff to manage the event and re-route surrounding traffic. In addition, the Operating Department may want to recruit volunteers or nonprofits to help host and operate the event, without incurring additional costs.

5. Launch Car-Free Sunday Pilot

Lead Agency: Department of Health and Wellness

Once launched, the Operating Department will monitor and improve the program so that it benefits local vendors, creates programming that meets public demand, and respects surrounding residential areas that may be impacted by changing traffic flows.

¹⁰ The Alliance for Biking & Walking and The Street Plans Collaborative, "The Open Street Guide," 2012 https://nacto.org/docs/usdg/smaller_open_streets_guide_final_print_alliance_biking_walking.pdf.

IMPLEMENTATION PLAN: GAMIFICATION

1. Conduct a Baseline Survey

Lead Agency: Department of Health and Wellness and UCTC

A baseline survey is necessary to inform decisions regarding transit-mode, target audiences, and the types of rewards and incentives to attract potential participants.

2. Set Goals and Identify Target Audience

Lead Agency: Department of Health and Wellness

Based on survey results, the Department of Health and Wellness will select a target audience and set specific, measurable goals such as increasing pedestrian activity or increasing public transit ridership.

We recommend that adults under 50 age be the primary target audience, as they are likely to own smartphones and respond to discounts provided by local businesses. In addition, students and teenagers could be an additional target audience — as this group is easily engaged in gaming and peer competition and could be encouraged to participate during their daily commute to school.

3. Procure a Software Provider

Lead Agency: Department of Health and Wellness

Once the goals of the program are established, the Department of Health and Wellness should procure vendors to implement the program. Vendors will likely include third-party software applications but could also include companies who develop manual “tap” card systems or marketing partners.

4. Partner with Local Businesses

Lead Agency: Department of Health and Wellness and Office of Economic and Community Development

Rewards should be designed and tailored to promote mode shift that aligns with sustainability goals. The Office of Economic and Community Development can identify local partners that are willing to offer rewards such as vouchers for sports club memberships, discounts for bike rentals, or coupons for cafes. The Department could also give additional points to those who participate in other government programs. For example, if residents take a computer course or if children participate in the Mayor’s Kayaking program, they could also earn points. Engaging people who are already participating in other programs could help build a user base.

5. Develop Marketing Strategy

Lead Agency: Department of Health and Wellness

The Department of Health and Wellness should develop a marketing strategy to reach target audiences and engage with participants. Strategies could include promotions that attract new users.

6. Establish Data Privacy Policy

Lead Agency: Department of Health and Wellness and City Corporation Counsel

Because the program utilizes a software application, data privacy protections will be needed to prevent unauthorized user location data and/or user rewards redemption data sharing with third-parties (either purposefully or accidentally). For example, if using a third-party software application like Miles, the City should develop controls so that data is not be sold or used for targeted advertising.

7. Launch the Pilot and Analyze Results

Lead Agency: Department of Health and Wellness

Once launched, the Department of Health and Wellness should continue to refine and improve the program to influence transit behaviors. Iteration could include improving incentives, reaching additional audiences, and ensuring that participants continue using the program over the long-term.

FINANCIAL MODEL

The following tables provide descriptions of all components costs for the Car-Free Sunday Pilot and the Gamification Pilot. The pilot is not designed to generate revenue.

CAR-FREE SUNDAY

ITEM	DESCRIPTION	COST RANGE
Marketing	The upfront cost for promotion, advertising, and communications	\$ 5,600 on average per year
Activities and Programming	Costs for activity setup and special events to engage with public	\$1.36 per a participant, per event
Police Deployment	Police presence for event security and traffic re-routing	\$5,700 estimated, per event

GAMIFICATION

ITEM	DESCRIPTION	COST RANGE
Software Licensing	Contracting a third-party software application to track user transportation behaviors and offer redeemable rewards Initial costs include marketing, rewards, data collection, and software license ¹¹	\$50,000 per 1,500 users
Maintenance	Estimated as 20% of initial development costs Includes program monitoring, engagement, and marketing	\$10,000 per year

¹¹ Mark Anderson, "Sacramento testing app that rewards users for walking, biking" Sacramento Business Journal, March 28, 2019 <https://www.bizjournals.com/sacramento/news/2019/03/28/sacramento-testing-app-that-rewards-users-for.html>.



SMART PARKING

CONTEXT

As of 2010, the transportation sector is responsible for 40% of Kingston's GHGs. This level of emissions is driven primarily by the usage of automobiles for transportation, even for short trips. Further, the city is suffering from considerable levels of congestion, owing to high traffic and limited space.

As Kingston's Climate Action Plan identified, parking price and availability can influence the decision to drive. To design a parking policy that aligns with sustainable mobility goals, the City is already considering "providing a tax benefit or financial incentive through parking policies and fees that offer incentives to use transit."¹

Smart parking infrastructure can help create these financial incentives in ways that reduce congestion and promote mode shift, while also providing tools that improve connectivity for Kingston residents and employers.

KEY FINDINGS ADDRESSED

1. Kingston is over-reliant on automobiles as its primary mode of transportation.
5. Parking space in Kingston's commercial districts is in short supply.
6. Kingston's street network and signaling system is outdated and complex.

¹ "Climate Action Plan," City of Kingston, September, 2012, [https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_\(1\).pdf](https://kingston-ny.gov/filestorage/8463/10432/10440/10458/CAP_-_Updated_for_PS_9-27-12_(1).pdf).

PROPOSAL

Smart parking is composed of devices and networks which connect parking spaces to the cloud to enable the flow of information throughout the transportation system. Smart parking improves the matching of supply and demand by relaying price and availability information through sensors and flexible pricing, as well as improving usability and accessibility by making multiple payment options available.

We propose two pilots for smart parking that can be implemented in Kingston and then evaluated for success: parking sensors and dynamic pricing.

Parking Sensors

Parking sensors have three main uses. The first is to automate enforcement, the second is to inform dynamic price adjustments, and the third is to enable the integration of curbside space into the wider transportation information architecture to inform decision-making. As an example, parking sensors can enable a seamless transition towards a parking system integrated with reservation and wayfinding technology.

For the purposes of the Kingston pilot, we propose using sensors to inform availability planning and dynamic pricing. In the future, Kingston could transition toward using sensors for enforcement, reservations, and wayfinding.

Dynamic Pricing

Dynamic pricing has been shown to significantly reduce cruising and congestion surrounding high-demand areas. Increasing the price for high-demand parking areas can also support commercial activity by increasing parking turnover, which adds foot traffic.

Smart parking is composed of devices and networks which connect parking spaces to the cloud to enable the flow of information throughout the transportation system.

VALUES ADDRESSED

SUSTAINABILITY

Dynamic pricing can be used as a tool for reducing congestion in peak locations and times. The price differential disperses parking demand to other areas and locations which are typically underutilized. This demand-smoothing increases average availability and reduces cruising. The result in some cases was a 30% reduction in total GHG emission from vehicles, due to the effect of faster parking and increased usage of vehicle alternatives.² Parking sensors also contribute to sustainability by informing policy makers and drivers of parking space availability. Availability drives adjustments to parking rates; rates are shared with users who are deciding whether to drive or not, as well as where to park. This leads to the optimization of parking prices so that the most sustainable outcome can be achieved.

FINANCIAL VIABILITY

The higher prices introduced by dynamic pricing in some areas and times can be offset elsewhere by lower prices. Dynamic pricing is often revenue neutral, as only those who are willing to pay often park in high price areas, with the increase in revenue offset by lower overall demand as more people choose to walk or use public transit. Additionally, higher prices in some cases have supported faster turnover for parking spots, leading to increased economic activity. Parking sensors often recover their minimal installation costs through easier enforcement. The benefits to consumers in terms of reduced congestion and potential for parking reservation and wayfinding technology are net positive.³

ACCESSIBILITY

Although the increased price of some parking spots will be a cause for concern for some city officials, the higher prices introduced by dynamic prices in

some areas can be offset elsewhere by lower prices. Dynamic pricing may adversely affect residents of denser neighborhoods; however, this can be managed by introducing a free or reduced-fee parking scheme for residents.

When fully deployed, sensor-enabled parking enforcement may face accessibility and adoption challenges in that users will have to use new meters or mobile apps to pay for parking. This could be managed by holding education and training workshops so that all segments of the population are aware and able to adapt to changes. Additionally, new meters could have cash payment options for users to who prefer traditional payment methods.

To design a parking system that provides access for those with disabilities, ADA-compliant parking spaces can be free in any location and improved enforcement will reduce violations so that these spots are available to those who need them. In addition, overall increases in parking availability will help these users get to where they are going faster.

SYSTEM-WIDE SYNERGY

Pricing parking spots in locations and during times that are more in-demand than others can signal to transportation users that congestion or over-demand is taking place. Pricing differences are an improvement in information transmission, which allow users to make informed choices about their mode of transportation, as well as their destination.

Parking sensors have the ability to plug space into the transportation system directly, enabling technologies like availability-based dynamic pricing, parking reservation, and wayfinding integration to be implemented.

² "Pilot Evaluation," SF Park, accessed May 2019 <http://sfpark.org/about-the-project/pilot-evaluation/>.

³ Tahon, Mathieu & Verbrugge, Sofie & Lannoo, Bart & Ooteghem, Jan & De Mil, Pieter & Colle, Didier & Pickavet, Mario & Demeester, Piet, "Parking sensor network: Economic feasibility study of parking sensors in a city environment," 2010 9th Conference of Telecommunication, Media and Internet, 2010, https://www.researchgate.net/publication/251941708_Parking_sensor_network_Economic_feasibility_study_of_parking_sensors_in_a_city_environment.

CASE STUDIES

San Francisco, California

San Francisco implemented SFpark, a demand-responsive parking pricing program, as a pilot in 2011 across some of the most congested areas of the City, including the Financial District. SFpark, which required the installation of new meters and parking occupancy sensors, uses pricing to open up parking spaces on each block and reduce circling and double-parking. Rates can vary by block, time of day, and day of week.

An evaluation of the pilot found that areas with dynamic pricing for on-street parking experienced greater on-street parking availability, reductions in congestion and VMT due to decreased cruising, and lower parking rates. In December 2017, the SFMTA Board voted to expand the program citywide. Officials stress that the new approach to setting

parking rates in San Francisco based on demand is not intended as an effort to raise parking revenue. In fact, the new system will likely be revenue neutral because rates on many streets and in garages will likely drop. As of 2019, no meter had reached the \$8 per hour cap.⁴

Ghent, Belgium

The City of Ghent was able to implement a city-wide program to use parking sensors for enforcement (independent of pricing). The program led to a significant improvement in enforcement, generating around 40% additional revenue from parking fines for the City and improving the availability of parking for residents.⁵

⁴ Pilot Evaluation, SF Park, accessed May 2019, <http://sfpark.org/about-the-project/pilot-evaluation>.

⁵ Ibid.

IMPLEMENTATION PLAN

1. Establish an Operating Department

Lead Agency: Implementing Agency

The pilot's Implementing Agency should be the same entity which oversees the City's current parking and payment program. The day-to-day operations will include the installation and management of the smart parking initiative's infrastructure, as well as maintenance, customer service, and public engagement.

A recommended staffing plan would include an additional staff member to manage contractors in the installation phase and oversee integration and operations once the program is operational.

2. Define the Target Area

Lead Agency: Implementing Agency

The Implementing Agency will need to define the boundaries of the pilot area. We have suggested the Stockade District due the current congestion experienced by visitors to the area, as well as the high demand that will be likely to continue in the event of an increased parking fee.

3. Determine Pricing Structure

Lead Agency: Implementing Agency and Operating Department

The Implementing Agency and the City Department responsible for management of parking prices will cooperate to develop pricing policy for the program. The pricing structure should include a target for availability, a minimum and maximum price, and the minimum and maximum adjustment per review cycle, as well as the length of a review cycle. The

Implementing Agency will also consider equity or accessibility goals such as providing discounts for low-income residents, students, or seniors.

4. Pass Municipal Ordinances Necessary to Operate System

Lead Agency: Implementing Agency and City Corporation Counsel

A legal review should be conducted to determine what municipal ordinances may be needed to adjust the City's parking prices on a regular basis.

5. Obtain Feedback from Residents

Lead Agency: Implementing Agency and City Corporation Counsel

Collect feedback from city residents on the program to understand the range of financial tolerance which city residents will respond to (for example, this will help refine the pricing policy for maximum effectiveness without complete distortion of parking market). This may also involve benchmarking different areas or streets to gauge optimal deployment locations.

6. Procure All Hardware and Software Components

Lead Agency: Implementing Agency, Operating Department, and IT Department

The Implementing Agency and Operating Department should collaborate to define technical requirements for all hardware and software components and to procure components that meet or exceed requirements.

7. Procure All Operational and Regulatory Components

Lead Agency: Implementing Agency, Operating Department, and IT Department

The Implementing Agency and Operating Department should collaborate to define technical requirements for all operational and regulatory components and to procure components that meet or exceed requirements.

8. Set Hours of Operation and Maintenance Schedule

Lead Agency: Operating Department

The Operating Department will need to develop a plan for installation of hardware and inspection and maintenance schedules.

9. Deploy Branding, Marketing, and Public Engagement Strategy

Lead Agency: Implementing Agency

Prior to the initiative's launch, the City will need to develop a public engagement strategy to educate consumers and prepare drivers for upcoming changes. The City should also develop a media strategy that would raise attention for the system's launch.

10. Launch System and Collect Performance Data to Improve Operating Strategy

Lead Agency: Operating Department

After initial system launch, the Operating Department will be responsible for tracking performance and adjusting pricing policies to improve availability and minimize disruption. The Implementing Agency may issue specific quarterly or annual reporting requirements to track the initiative's effectiveness.

— Key Performance Indicators

PARKING AVAILABILITY

Mean time for users to find parking spot
(in minutes)

Vehicle turnover: numbers of cars per spot per day

PARKING ENFORCEMENT

Monthly revenue from parking fines (in \$)

Monthly revenue from parking reservations (in \$)

Monthly costs of parking enforcement (in \$)

COMMUNITY ENGAGEMENT

Resident satisfaction: evaluate the satisfaction and perception of increased parking availability among residents

FINANCIAL MODEL

The following tables provide estimates of component costs and revenues for the Smart Parking pilot.⁶ The full model is available in Appendix D. Examples and evaluation of sensor types and providers can be found in the SF Park guide.⁷

HARDWARE COSTS

ITEM	DESCRIPTION	CAPITAL COST RANGE	O&M COST RANGE
Sensor Node	Physical sensor installed on the ground (either on or in asphalt), a range of technologies is available	\$8 to \$30	~30% annual replacement is typical
Cluster Node (CN)	Connects sensors to the base station through the cloud	\$500 to \$2,000	n/a
Base Station (BS)	Server for receiving the information from the system and relaying it to a user interface	\$2,000 to \$5,000	n/a
Central Database	Cost for setting up a database	\$3,000 to \$10,000	n/a
Custom Design Hardware	These costs include the design of a Printed Circuit Board (PCB) with sensor, power circuit and transceiver, and the design of the gateway to transmit data from the CN to the BS. In addition, this cost includes the certification of the hardware.	\$100,000 to \$150,000	n/a

6 Tahon, Mathieu & Verbrugge, Sofie & Lannoo, Bart & Ooteghem, Jan & De Mil, Pieter & Colle, Didier & Pickavet, Mario & Demeester, Piet. (2010). Parking sensor network: Economic feasibility study of parking sensors in a city environment. 2010 9th Conference of Telecommunication, Media and Internet, https://www.researchgate.net/publication/251941708_Parking_sensor_network_Economic_feasibility_study_of_parking_sensors_in_a_city_environment.

7 "Parking sensor technology performance evaluation," SF Park, June 26, 2014, <http://sfpark.org/resources/parking-sensor-technology-performance-evaluation/>.

SOFTWARE COSTS

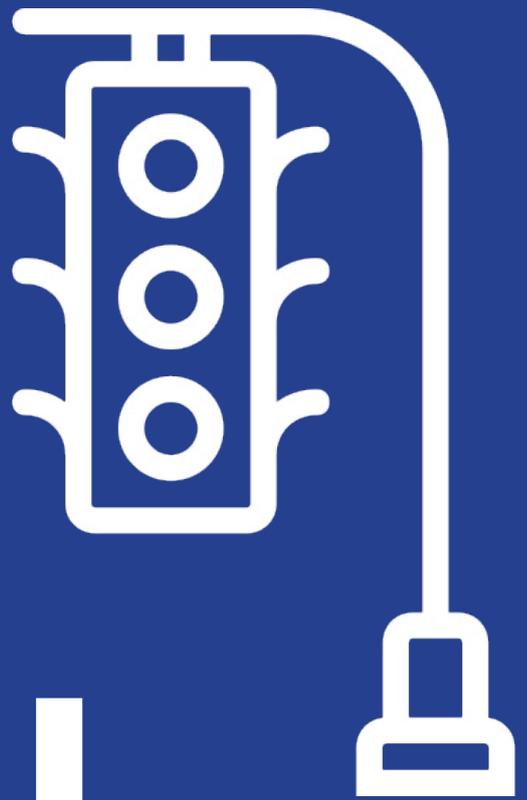
ITEM	DESCRIPTION	CAPITAL COST RANGE (per intersection)	O&M COST RANGE (per intersection)
Custom Design Software	The software development covers different aspects of software integration. In addition, adding security to the communication protocol is a major requirement and will require custom programming.	\$50,000 to \$100,000	n/a
Integration with Whoosh App	Estimate for the cost of Whoosh to integrate dynamic price updates into their system based on location. Cost could be reduced if updates are made manually.	\$25,000 to \$50,000	n/a

OPERATIONAL COSTS

ITEM	DESCRIPTION	COST RANGE
Additional Staff Costs	Additional staff capacity required to install, maintain, and manage operational needs	\$30k-80k annually

POTENTIAL REVENUES

ITEM	DESCRIPTION	COST RANGE
Pricing	Revenue increases from higher parking prices	Negligible, offset by lower parking elsewhere
Enforcement	Revenue increases from improved parking compliance	15-20% per parking spot



SIGNAL PRIORITY

CONTEXT

Kingston is currently working to improve its outdated traffic signaling infrastructure through major projects including the Broadway Streetscape Project and the I-587 Intersection Project.¹ However, as the City updates its infrastructure, it will be critical to consider how improvements will influence transit behaviors.

In its 2040 Long Range Transportation Plan, the Ulster County Transportation Council explores opportunities to use advanced traffic signal systems and data-driven traffic management to produce more efficient mobility and to improve pedestrian safety.² However, while moving people safely and efficiently is important, infrastructure investments should also be designed to promote transportation that aligns with sustainability goals. If increased throughput makes driving easier, the City could see increases in VMT and transportation-related emissions.

Kingston has already started integrating sustainability into its transportation infrastructure by installing a network of EV charging stations, constructing the Greenline trail network, restoring aging sidewalks, and developing a Pedestrian and Cyclist Master Plan.³

However, there are opportunities to integrate emerging technology tools to further these efforts. Smart signaling infrastructure is one promising innovation that can be used to optimize traffic flows, reduce congestion, and give priority to sustainable modes of transportation.

KEY FINDINGS ADDRESSED

1. Kingston is over-reliant on automobiles as its primary mode of transportation.
2. Kingston's public transit system struggles to provide adequate frequency and coverage to city residents.
6. Kingston's street network and signaling system is outdated and complex.

1 "Kingston On The Move," City of Kingston, accessed May 2019, <https://www.kingston-ny.gov/kingstononthemove>.

2 "Ulster County Year 2040 Long Range Transportation Plan," Ulster County Transportation Council, October 1, 2015, https://www.villageofnewpaltz.org/download/archives/sustainability_resources/ms4_resources/Ulster-County-Long-Range-Transportation-Plan-Year-2040.pdf.

3 "Kingston Greenline," City of Kingston, accessed May 2019, <https://www.kingston-ny.gov/kingstongreenline>; Interview with City Officials, February 8, 2019.

PROPOSAL

We recommend that Kingston implement a Transit Signal Priority (TSP) system, which will connect traffic signals to public transit buses. The TSP system facilitates communication between signals and buses so that buses receive a green light as they approach an intersection. A TSP system can be programmed to hold green lights longer or to shorten red lights, so that as buses approach they receive signal priority. TSP systems can be active, passive, or real-time systems. Active TSP systems will only send a TSP request if the bus is behind schedule. Passive TSP systems will give priority to a bus every time it approaches the intersection. Real-time TSP can give priority based on the need of the intersection.⁴ Overall, the goal of a TSP system is to increase on-time arrivals and reduce travel times so that levels of service are improved throughout the public transit system, without requiring major infrastructure investments like dedicated bus lanes.

The TSP system is comprised of different parts, including hardware, data management, and software. The data center receives traffic data, uses software to analyze the data, and send commands back to traffic controllers, which then adjust signals accordingly.

To enable the full functionality of a complete TSP system, we suggest a complete upgrade of the current system:

Upgrade signal controllers to open operating systems, which can share resources with other networks.

Install updated versions of communication tools like DSRC (dedicated short-range communications), radio, cellular, Wi-Fi, or Bluetooth. These tools will facilitate communication between vehicles and controllers and other infrastructure.

Build a traffic management data hub to collect and analyze comprehensive data and optimize traffic loads.

Integrate existing bus GPS system to enable buses to communicate with traffic controllers and traffic management centers.

⁴ "Surface Transportation Optimization and Bus Priority Measures: The City of Boston Context" A Better City, March 2013, <https://www.abettercity.org/docs/Surface%20Transportation%20Optimization%20and%20Bus%20Priority%20Measures%20Final.pdf>.

The TSP system facilitates communication between signals and buses so that buses receive a green light as they approach an intersection.

VALUES ADDRESSED

SUSTAINABILITY

Congestion and delay results in vehicles functioning at below-optimal speeds. Stop-go behavior results in greater acceleration and deceleration events, leading to incomplete combustion and additional emissions. Since the implementation of TSP may create delays for non-transit vehicles, it is important to consider impact on emissions throughout the traffic network.⁵ A USDOT study of Eco-Transit Signal Priority algorithms found that when TSP algorithms were optimized for both bus priority and overall network emissions, total emissions decreased by 1% to 2%, and travel times improved by 1% to 3%.⁶ However, this does not include emissions reductions related to mode shift that may occur if public transit service levels improve.

FINANCIAL VIABILITY

If existing software and controller equipment can be used, TSP system costs can be under \$5,000 per intersection; however, costs can rise to \$20,000-\$30,000 per intersection if traffic controllers need to be replaced.⁷

In addition, a TSP system will improve public transit services which could lead to increased ridership and increased revenue for the public transit system. For example, after installing a TSP pilot in Toronto, transit signal delays decreased by 15-49%. The city expanded the system to

over 135 signalized intersections along one bus and four streetcar routes, all in mixed traffic.⁸ A detailed impact on revenue generation is difficult to estimate; however, we are likely to observe positive impacts as service improves.⁹

ACCESSIBILITY

According to the Ulster County Coordinated Public Transit-Human Services Transportation Plan, groups with a higher propensity to take public transit include older adults, youth, those with disabilities, veterans, those with limited English proficiency, and households living with incomes below the poverty line.¹⁰ By improving the reliability and efficiency of the public transit system, TSP will improve mobility for these groups.

SYSTEM-WIDE SYNERGY

Transit signal priority creates positive spillover effects by improving both public transit and traffic signals. In addition, TSP works to reduce private automobile usage by creating infrastructure that prioritizes shared modes. As connected vehicles and connected infrastructure develops in the long run, one could envision a signal priority system that extends beyond buses to give priority to cyclists, pedestrians, or electric vehicles in the shared City Fleet system.

5 Wijayaratna, Kasun, et.al, "Emissions Impacts of Transit Signal Prioritization," Australian Transport Research Forum, October 2013, https://atrf.info/papers/2013/2013_wijayaratna_dixit_mao_walker.pdf.

6 "Preliminary Eco-Traffic Signal Priority (for Transit and Freight) and Connected Eco-Driving Modeling Results," US Department of Transportation, February 12, 2014, https://www.its.dot.gov/research_archives/aeris/pdf/Eco-TrafficSignalPriority_ConnectedEco-Driving.pdf.

7 "Transit Signal Priority - Costs," US Department of Transportation Costs Database, accessed May 2019, <https://www.itscosts.its.dot.gov/ITS/benecost.nsf/0/5156DF30E0F4FCE9852573E90063D12C?OpenDocument&Query=Home>.

8 "An Overview of Transit Signal Priority," Intelligent Transportation Society of America, July 11, 2002, <https://azmag.gov/Portals/0/Documents/pdf/cms.resource/Transit-Signal-Priority.pdf?ver=2002-11-22-112900-000>.

9 "Surface Transportation Optimization and Bus Priority Measures: The City of Boston Context."

10 "Ulster County Coordinated Public Transit-Human Services Transportation Plan," Ulster County Transportation Council, February 2017, <https://ulstercountyny.gov/sites/default/files/documents/planning/ULSTER%20CO%20HSTCP%20Update%202016%20FINAL.pdf>.

CASE STUDIES

Petaluma, California

As of 2019, Petaluma, California has implemented TSP in 31 intersections. The City implemented the project in three phases from 2014 to 2017. Petaluma's TSP system was programmed to work for both public buses and emergency vehicles. This dual-use provides cross-departmental benefits by replacing traffic signal control equipment without impacting the Traffic Division General Fund budget, while improving emergency response times for the Fire Department. Evaluations of the project found that the pilot helped reduce idling time and delays of buses, leading to less carbon dioxide emissions and improved safety for travelers and pedestrians.¹¹

New York City, NY

Since 2012, the New York City Department of Transportation (NYCDOT) has worked with the Metropolitan Transportation Authority (MTA) to implement TSP on five corridors. The implementation required the installation of GPS technology on buses by the MTA and substantial traffic analysis from NYCDOT to facilitate

maximum traffic flow while maintaining sufficient pedestrian crossing time. On average, TSP reduced bus travel times by 14% during weekday peak morning and evening commuting periods. Results vary by corridor, direction, and time of day, with travel time savings ranging from less than 1% to up to 25%. It is most beneficial on two-way streets outside Manhattan and when a full substantive traffic analysis underlies the work to maximize safety and transportation benefits.¹²

Phoenix, Arizona

Significant improvements have been made to the Phoenix Metropolitan Area's transit system over the last 15 years as a result of local and regional sales tax initiatives. The City of Phoenix conducted a TSP demonstration using the 3M Opticom system. The system was used for transit vehicle detection to provide two priority strategies — early green and green extension. The study also identified three of the six intersections with green extensions limits from 6 seconds to 9.5 seconds. Transit benefits per intersection were calculated at \$5,932 annually.¹³

¹¹ Joe Rye and Dan St. John, "Letter to Petaluma Mayor and City Council," September 18, 2017, https://petaluma.granicus.com/MetaViewer.php?view_id=3&clip_id=2394&meta_id=380759.

¹² "Green Means Go: Transit Signal Priority in NYC," NYCDOT, January 2018, <http://www.nyc.gov/html/brt/downloads/pdf/brt-transit-signal-priority-july2017.pdf>.

¹³ "The Phoenix Transit Plan," City of Phoenix Public Transit Department, accessed May 2019, https://www.phoenix.gov/publictransitsite/Documents/d_043453.pdf.

P I L O T

The new TSP system will include:

- Equipment necessary for the system to be operational (e.g. signal controllers, loops, vehicle detectors, on-board equipment, etc.)
- Hardware necessary for system deployment
- Software necessary for system operations
- Interfaces with other ITS systems
- Personnel necessary to operate and maintain the system
- Facilities necessary to meet the needs of the fully functional system, in particular related to public transit systems like buses

Controllers

The traffic signal controller is the device that controls the signal. The traffic signal controller also stores all the timing parameters of how long each direction should stay green, yellow, or red. More than 40% of the transit agencies surveyed reported the use of NEMA traffic signal controllers, which are currently the most widely deployed type of signal controller in the United States. 19% of agencies reported the use of Type 170 and 23% for Type 2070 controllers.¹⁴

Software

As previously stated, more than 40% of the surveyed transit agencies reported the use of NEMA traffic signal controller hardware. A small number

of transit agencies reported the use of third-party TSP software packages that generally offer more flexibility than the TSP software provided with NEMA controllers. These software packages include BiTran, Wapiti, and NextPhase.

Communication Equipment

Communication is a very important element of the TSP system. It provides a connection among TSP elements. The reliability of the TSP system is completely dependent on the communications system. The communication system needs to be upgraded to V2X version, instead of using closed systems. The V2X system could use DSRC, radio, cellular, Wi-Fi, or even Bluetooth to communicate between vehicles and infrastructure.

Typically, radio systems are used to communicate between the transit management system and the transit vehicle. Recently, new wireless technologies, such as cellular data (CDPD) have been successfully applied. These systems allow the vehicle to report location and other vital information to the transit management system. The key consideration is the communication range, which can affect how far in advance a priority can be received. Recently other types of communication methods such as Wi-Fi or Bluetooth are also being used in systems as they can provide longer distance of communication and more reliable data transmission.

¹⁴ Smith, Harriett, et. al, "Transit Signal Priority: A Planning and Implementation Handbook," US Department of Transportation, May 2005, <https://www.gtt.com/wp-content/uploads/Transit-signal-priority-A-planning-and-implementation-handbook.pdf>.

IMPLEMENTATION PLAN

1. Designate an Implementing Agency

Leading Agency: Implementing Agency

An Implementing Agency needs to be in charge of the whole process, including selecting intersections, working with third-party consultants, procuring equipment, monitoring installation, and maintaining equipment long-term.

The City of Kingston is already working with GPI on signal system improvements; thus, this team of city employees could provide leadership on integrating a Transit Signal Priority program.

2. Determine Priority Intersections

Lead Agency: Implementing Agency, UCTC, and UCAT

We recommend the pilot could be implemented along transit routes with significant ridership and significant on-time arrival challenges. In discussion with UCAT, the new route running through the City of Kingston along Broadway Street could be a good location because of its density and high anticipated ridership. In addition, TSP improvements could be included in existing infrastructure redevelopment along the corridor.

The detailed selection process depends on the vision and scope of the project. In some cases, the system will be installed in places with the most traffic problems. In other instances, a corridor is predetermined because it has already been chosen as a BRT corridor. Regardless, it may be necessary to perform an analysis or consult third-party to prove to decision-makers that the project is warranted and likely to produce the desired results.

3. Measure Baseline Conditions

Lead Agency: Implementing Agency

To measure the system's results effectively, baseline data should be collected to determine traffic volumes, turning movements, pedestrian crosswalk volumes, and bus delay and dwell times. Developing a baseline condition will be critical for measuring TSP impacts.

4. Establish Data Privacy Policy

Lead Agency: Implementing Agency

Data collected by the TSP system would be gathered in the data management center, which will be used to analyze and optimize traffic flow. A standard needs to be set regarding who can access this data and how it can be used.

5. Prepare RFPs

Lead Agency: Implementing Agency

The RFP or bid documents should require:

All functions the agency wants performed including an explanation of how TSP solution will handle a listing of any data the transit agency or traffic engineering office wants collected.

A listing of any reports the transit agency or traffic engineering office wants created with collected data.

Access to data and the ability to create future reports.

Compliance with specified ITS standards, including whether the new technology will be comparable with existing traffic system and also with the one that will be implemented.

Required design and engineering for installation at intersections.

Required design and engineering for installation and interface with central control and communications systems.

6. Vendor Selection and Procurement

Lead Agency: Implementing Agency, Third-Party Consultancy, and Installation Team

Most agencies create a team to review proposals and select a vendor. The team will be drawn from the already-identified stakeholders. The team will include the Implementing Agency, third-party consultancies, and the actual installation team which will implement the project. If there are questions in the proposals provided by each vendor, the team may want to have a meeting with each vendor to clarify all issues. After the stakeholder team has selected the successful responder and informed all respondents as to their selection or non-selection, there may be further negotiations and clarifications with the successful vendor.

Potential vendors could include: Econolite, Safetran, GTT, McCain Inc, Reno A&E, GE, Campbell-Company, Intuicom, JSF-Technologies, TrafficCast, Chemque, WTI, Pelco Products Inc., and Alpha Technologies.

7. Installation of All Components

Lead Agency: Implementing Agency and Installation Team

To install bus and controller equipment, the traffic engineering office will have to coordinate with the vendor and/or engineering consultant for field installation, and the vendor will have to conform to the traffic engineering office's accepted procedures for installation to reduce liability. The City's IT office can oversee the process so that technology is appropriately installed.

8. Train All Affected Crew

Lead Agency: Implementing Agency

After implementing new signal systems, bus drivers may need to be trained on what to expect and how changes may affect their driving patterns.

9. Launch and Monitor TSP System

Lead Agency: Implementing Agency

After implementing the pilot at selected intersections, the Implementing Agency should measure its impact on traffic and emissions and adjust management practices to continue making improvements. If successful, the pilot could be expanded to other intersections throughout the UCAT system.

— Key Performance Indicators

SERVICE IMPROVEMENTS

On-Time arrival rate: increase in on-time arrivals along pilot route

INCREASED RIDERSHIP

Increases in monthly and annual ridership

Passenger satisfaction: evaluate the satisfaction and perception of improved bus service among passengers

EMISSION REDUCTIONS

Reduction in GHGs: reduced fuel usage for buses compared to usage prior to pilot implementation; reduction in total emission along affected corridors

Reduction in congestion: the Implementing Agency should track traffic congestion data and compare with baseline conditions

FINANCIAL MODEL

The following tables provide descriptions of component costs for the Transit Signal Priority pilot, including controllers, communications equipment, and software.¹⁵ The pilot is not designed to generate revenue.

CONTROLLERS

ITEM	DESCRIPTION	CAPITAL COST RANGE (per intersection)	O&M COST RANGE (per intersection)
Signal Controller Upgrade for Signal Control	Local controller upgrade to provide advanced signal control	\$1,900 to \$5,000	\$200 to \$300
Signal Controller and Cabinet	Includes installation of traffic signal controller per intersection	\$6,000 to \$11,000	\$200 to \$400
Signal Controller Upgrade for Signal Preemption	Add-on to base capability (per intersection); Complement of IDAS elements RS004 and TV004	\$2,000 to \$3,000	n/a
Roadside Signal Priority	Includes infrared detector, detector cable, phase selector, system software, and installation. Capital cost range is for two-directions. O&M cost estimate for operating, monitoring, and maintaining.	\$4,000 to \$5,000	\$200 to \$1,000

COMMUNICATIONS EQUIPMENT

ITEM	DESCRIPTION	CAPITAL COST RANGE (per intersection)	O&M COST RANGE (per intersection)
DS1	1.544 Mbps capacity (T1 line). Leased with typical distance from terminus to terminus is 8 to 15 miles, but most of the cost is not distance sensitive.	\$500 to \$1,000	\$5,000 to \$10,100
DS3	44.736 Mbps capacity (T3 line). Leased with typical distance from terminus to terminus is 8 to 15 miles, but most of the cost is not distance sensitive.	\$2,900 to \$4,800	\$24,000 to \$71,000
Wireless	1,000 Kbytes/month available usage (non-continuous use).	n/a	\$600 to \$700

The Implementing Agency can choose from DSRC, cellular, or Wi-Fi. Generally, DSRC is more expensive and more accessible than others.

SOFTWARE COSTS

ITEM	DESCRIPTION	CAPITAL COST RANGE (per intersection)	O&M COST RANGE (per intersection)
Information Service Provider Software	Includes database software (COTS) and traffic analysis software. This cost may be avoided if current systems can be adapted to operate with TSP system.	unknown	\$14,100 to \$28,200

Software costs can range depending on the City's current system. If more new functionality is needed, the capital costs can be relatively high.

EXAMPLE COSTS: PETALUMA, CA

To provide an overarching example of potential pilot costs, Petaluma, California reported the following costs per intersection. However, their system did not require controller updates or software upgrades, as selected TSP equipment could operate alongside their current systems.¹⁶

ITEM	DESCRIPTION	COST (per intersection)
Opticom 764, 4 channel multimode phase selector	Hardware	\$2,200
Opticom interface panel for the 760 series phase selector	Hardware	\$340
GPS radio unit (Mast mount)	Hardware	\$2,695
GPS cable 2500'	Hardware	\$2,025
Opticom emitter	Hardware	\$3,020
Opticom installation	Operational	\$1,700

16 Provided by City of Petaluma Department of Public Works, April 17, 2019.

— Sustainable Mobility Enablers

MANAGEMENT STRUCTURE

Smart Mobility Governance

There is no one-size-fits-all approach to smart mobility governance. The City of Columbus, Ohio, winner of the U.S. Department of Transportation's (USDOT) first-ever Smart City Challenge, offers lessons in smart mobility governance that can be instructive for Kingston. Columbus was awarded \$50 million in grant funding and designated America's Smart City.¹ Central to the innovation in Columbus were the efforts of the Smart Columbus city staff. Yet, they could not do it alone. Cross-sector collaboration was instrumental between Smart Columbus and the Columbus Partnership, a civic business organization dedicated to regional economic development.² Given the smaller size of Kingston compared to Columbus, a tailored governance model should be considered that includes an agency or department in Kingston tasked with smart mobility, budget lines for staff in this unit, and strategies for cross-sector collaboration with business, academia, and non-profit organizations in the region.

Smart Mobility Vision Statement

Articulating a vision and strategy for smart mobility is key to the department's success. Columbus identified a "bold vision to be a

community that provides beauty, prosperity, and health for all of its citizens." This vision set the tone for the planning activities in the City. More specifically, this vision was aligned with activities related to clean transportation, non-motorized travel, smart technology, and inclusive economic development:

"A beautiful city provides clean transportation options that serve the mobility demands of the city and reduce the impacts on the environment."

"A healthy city provides safe and inviting opportunities for non-motorized travel and smart technology with a complete digital network that links people to services, such as healthy food and health care."

*"A prosperous city connects workers to jobs and employers to workers, gets goods to market, supports world-class institutions, and provides reliable travel options affordable to a range of household budgets."*³

As the City of Kingston moves forward and considers the sustainable mobility recommendations in this report, the agency or department that is accountable for leading the initiatives should establish a vision statement that sets the foundation for the work ahead.

¹ Smart Columbus website, <https://smart.columbus.gov/>.

² Nancy Torres, "How Columbus is Accomplishing its Smart City Vision," Harvard Kennedy School Ash Center for Democratic Governance and Innovation, March 29, 2018, <https://datasmart.ash.harvard.edu/news/article/how-columbus-accomplishing-its-smart-city-vision>.

³ Columbus Smart City Application, <https://www.transportation.gov/sites/dot.gov/files/docs/Columbus%20OH%20Vision%20Narrative.pdf>.

ADDITIONAL REVENUE SOURCES AND FINANCING OPTIONS

Monetization

Traditionally, the public sector funds infrastructure and operates a service to alleviate a market imbalance or provide a public good. The government can recover investments through fees. As cities continue to struggle to fund and finance transportation projects, innovative funding and financing concepts have emerged. Smart city projects collect a substantial amount of data that can serve as an alternative revenue source.

A Deloitte report on the challenge of paying for smart city projects noted: “The project sponsor might, for example, sell advertising space on an asset, monetize data that the service collects, form affiliate or strategic partnerships, and use these revenues to pay for the asset or the service for the city/public.”⁴

Local governments are increasingly considering monetizing open-data platforms. This does not necessarily mean putting a paywall around the data. Rather, the municipalities can charge for the data that is obtained beyond simple queries.⁵ As electric vehicles become more prevalent in the marketplace, that means less revenue from gasoline and diesel taxes to fund transportation initiatives. Mobility or transportation as a service leads to fewer drivers and less revenue from parking. The business case for monetization becomes more compelling as sustainable mobility initiatives are deployed successfully.

Monetized data from connected devices, infrastructure, and vehicles not only provides an opportunity to produce a new revenue stream, but the data can also serve a public good. For example,

licensing traffic data to a third-party navigation company can help to enhance route-planning capabilities. In another instance, the Tennessee Department of Transportation deployed IoT roadway sensors to detect fog and alert drivers of hazardous road conditions — creating a potential opportunity to sell the data to the National Weather Service to improve forecast accuracy.⁶ A report by Impact Mobility highlights decisions that cities will be facing as the ecosystem for the mobility marketplace takes shape:

“When it comes to city-owned data, the argument could be made that sharing it at no cost will benefit the public good by allowing for services that make private and public life better. On the other hand, should cash-strapped cities stand by and watch as private companies build potentially lucrative businesses with their data?”⁷

Road Usage Charge

The gas tax is static and is unlikely to change without Congressional action. Considering gridlock in Washington, exploring other revenue sources is crucial to fund transportation innovations. This need is more pronounced as cars become more efficient and gas revenues decline further.

Since 2007, various pilot programs for Road Usage Charge (RUC) systems (also called a VMT) have been conducted, mostly in the Pacific Northwest. One interstate pilot took place on the East Coast along the I-95 corridor. RUC is a sustainable innovation designed to help fund aging transportation infrastructure and supplement the insufficient Highway Trust Fund. More specifically, according to the National League of Cities, RUC requires drivers “to pay based on distance driven

⁴ Deloitte, “Funding and financing strategies for smart cities,” <https://www2.deloitte.com/us/en/pages/public-sector/articles/smart-cities-funding-and-financing-strategies.html>.

⁵ Benjamin Freed, “Smart cities’ contemplate turning big data into big money,” State Scoop, April 3, 2019, <https://statescoop.com/smart-cities-contemplate-turning-big-data-into-big-money/>.

⁶ Kyle Connor, “Transportation agencies can monetize IoT when data becomes the new oil,” Venture Beat, February 1, 2018, <https://venturebeat.com/2018/02/01/transportation-agencies-can-monetize-iot-when-data-becomes-the-new-oil/>.

⁷ Impact Mobility, “Report: Mobility Data Marketplaces and Integrating Mobility into the Data Economy,” May 2019, <https://events.impactconf.com/mobility-eu/>.

and, perhaps other costs of road use, such as wear and tear on roads, traffic congestion, and air pollution.”⁸

For localities that want to consider adopting the RUC, the National League of Cities issued four recommendations based on six pilot programs:

1. Encourage collaborative efforts
2. Gain state legislative buy-in
3. Understand public opinion
4. Provide the public with options

Assembly Bill A670 in the NY 2017–2018 legislative session was written to form a “pilot program designed to assess various issues related to implementing a vehicle–miles traveled fee.”⁹ The bill remained in the Assembly transportation committee. Given the political dynamics in the State legislature and greater awareness of the scarcity of transportation funding throughout the State, more efforts should be directed towards legislative action on an RUC pilot program.

Value Capture

Another emerging source for alternative revenue is value capture. Investments in transportation infrastructure can increase the value of adjacent land. Capturing this value as a finance mechanism for infrastructure investment is getting more attention from public finance practitioners.¹⁰

The U.S. Department of Transportation Center for Innovative Finance Support explains that “value capture techniques harness a portion of the increased property values in order to pay for the improvement or for future transportation investment.” According to the Federal Transit Administration, “value capture strategies generate sustainable, long-term revenue streams that can help repay debt used to finance the upfront costs of building infrastructure, such as transit projects.

Revenue from value capture strategies can also be used to fund the operations and maintenance costs of transit systems.”

The Federal Transit Administration also identifies examples of value capture strategies used for transit that include: tax increment financing, special assessments, and joint development.¹¹ Taking a closer look at special assessments, in this strategy property owners within a defined district are assessed a portion of the benefit accruing to their property as a result of the improvement.¹²

Value capture has been implemented in cities and regions of varying size. For example, transportation utility fees have been implemented in monthly utility bills by several small towns in Oregon. The fees are utilized to fund programs for local road maintenance and safety.¹³

Further, a couple of relevant cases of special assessment districts are Route 28 in Northern Virginia and South Lake Union Streetcar in the City of Seattle. In the case of Route 28 in Northern Virginia, localities were granted the ability by the Virginia General Assembly to create special tax districts to finance transportation improvements. Consequently, the Route 28 Transportation Improvement District was formed by property owners from Fairfax and Loudon counties. A special levy of \$.20 per \$100 valuation was enacted on commercial and industrial property.¹⁴

For South Lake Union Streetcar, a special property tax levy was established through the creation of a Local Improvement District (LID), which funded about 47% (\$25 million) of the \$53.5 million project.¹⁵ Property tax rates ranged from 1% to 8% depending on the proximity to the LID.

Municipalities like Kingston should identify state and local laws that prohibit value capture and explore remedies to alleviate those obstacles.

8 National League of Cities, “Fixing Funding by the Mile, A Primer and Analysis of Road User Charge Systems,” 2018, <https://www.nlc.org/sites/default/files/2019-03/Fixing%20Funding%20by%20the%20Mile.pdf>.

9 New York State Senate, “Assembly Bill A670, 2017–2018 Legislative Session,” <https://www.nysenate.gov/legislation/bills/2017/a670>.

10 University of Minnesota, Value Capture for Transportation Finance <http://www.cts.umn.edu/Research/featured/valuecapture/>.

11 Federal Transit Administration, “Value Capture,” <https://www.transit.dot.gov/valuecapture>.

12 US Department of Transportation, Federal Highway Administration, Center for Innovative Finance Support, “Special Assessments: An Introduction,” https://www.fhwa.dot.gov/ipd/fact_sheets/value_cap_special_assessments.aspx.

13 US Department of Transportation, Federal Highway Administration, “Value Capture: Capitalizing on the Value Created by Transportation,” https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/value-capture-factsheet.pdf

14 Ibid.

15 US Department of Transportation, Federal Highway Administration, Center for Innovative Finance Support, “Project Profile: South Lake Union Streetcar,” https://www.fhwa.dot.gov/ipd/project_profiles/wa_sl_u_streetcar.aspx.

Human Capital

Data analytic capabilities are necessary to utilize the information available in connected transportation components. To the extent that there is a shortage of expertise to maximize the value of smart mobility data, the Small Places, Big Ideas Innovation Cohort is an opportunity to bridge that gap. Engaging Local Government Leaders (ELGL) and Urban Leap are partnering on a one-year program for 25 small cities (under 30,000 population size) to form a collaborative community to share best practices and tools to test new smart mobility innovations.¹⁶ The Small Places, Big Ideas Innovation Cohort can serve as a compliment to additional revenue sources.

New York Green Bank

As a financing option, the NY Green Bank, a division of NYSERDA, partners with the private sector as a means to invest in clean energy solutions.¹⁷ An alternative to grant funding by state government, the NY Green Bank invests in projects that meet its investment criteria which include a positive return, potential to transform energy markets, and reduction in GHGs.¹⁸ Furthermore, the NY Green Bank seeks out entities that demonstrate success in clean energy whose future goals are restricted by lack of available funding.

Digital Street Media

LinkNYC has proven to be a popular innovation for the streetscapes of New York City. Revenue is generated through advertising, sponsorships, and partnerships, at no cost to taxpayers. The advertising platform is projected to bring in

millions of dollars of revenue to the City — \$500 million over 12 years. In terms more relatable to a smaller city like Kingston, across 7,500 LinkNYC kiosks, the projected annual revenue per kiosk is about \$6,000 per year.¹⁹

LinkNYC is operated by CityBridge, a consortium of companies including Intersection, Qualcomm, and CIVIQ Smartscales, consisting of subject matter experts in technology, user experience, connectivity, and advertising.²⁰ Time and place (TaP) services have also been deployed in subway stations and bus stops offering real-time alerts (e.g., countdown clocks), wayfinding, user-friendly features, and dynamic advertising content.²¹

There are several prominent examples of digital media to consider that may be appropriate for Kingston. One is a kiosk, such as a Link, that provides Wi-Fi and a range of public utilities. Another is a digital bus shelter on a high-traffic street utilizing large displays that offer advertising space.

Deployment of TaP devices in strategic locations throughout Kingston aligns to our equitable and accessible values in a small city mobility ecosystem. Leveraging the technological innovations in inclusive design, the kiosks can provide critical public service information to the disabled, low-income, and senior communities.²²

16 Chris Teale, "New innovation program will assist small cities, rural governments," Smart Cities Dive, April 12, 2019, <https://www.smartcitiesdive.com/news/innovation-program-assist-small-cities-rural-governments/552628/>.

17 NY Green Bank, A Division of NYSERDA, "NY Green Bank: Agent for Greater Private Sector Investment in Sustainable Infrastructure," <https://greenbank.ny.gov>.

18 Ibid.

19 LinkNYC Franchise Agreement, [https://www1.nyc.gov/assets/doitt/downloads/pdf/Franchise-Agreement-for-Public-Communications-Structures-\(REVISED-FINAL-12-10-2014\).pdf](https://www1.nyc.gov/assets/doitt/downloads/pdf/Franchise-Agreement-for-Public-Communications-Structures-(REVISED-FINAL-12-10-2014).pdf).

20 LinkNYC, <https://www.link.nyc>.

21 Intersection, <https://www.intersection.com/success-story/mta-time-and-place-arrivals/>.

22 Smart Cities for All, Inclusive Innovation Playbook, <https://smartcities4all.org/wp-content/uploads/2019/05/12-Playbook-XT.pdf>.

REGULATORY CONSIDERATIONS

Municipal Ordinances

The Administrative Code for the City of Kingston should be updated in “§ A-2 City departments and officers” to reflect a new mandate for the department(s) and officers responsible for sustainable city mobility innovation functions.²³

As our initiative implementation plans indicate, legal review should be conducted to determine how the Administrative Code for the City of Kingston should be modified to manage and operate City Fleet, Walk Kingston, Smart Parking, and Signal Priority. For example, the City of New York passed an ordinance that classified pedal-assist bicycles as Class 1 vehicles to secure their legal use. Additional ordinances may be needed to allow municipal vehicles to be driven by non-municipal employees.

Data Management and Privacy

Smart city deployments require a balance between data sharing and privacy. Based on guidance from the U.S. Department of Transportation on shared mobility, all data collected and stored across City Fleet, Walk Kingston, Smart Parking, and Signal Priority programs should comply with “clear and consistent data standards, data sharing protocols, and privacy protections to ensure open data, protection of consumer and proprietary operator data, interoperability, and comparability across a wide array of platforms.”²⁴

A legal, technical, and operational review should be performed to identify potential enhancements to these standards, protocols, and protections to facilitate compliance. To protect user data, mechanisms should be put in place to anonymize and aggregate user data to minimize the potential to identify individual users based on their usage habits. A careful examination of third-party agreements should take place to prevent and mitigate risks related to user data. Across our proposed initiatives, the Implementing Agency should also consider how to communicate its data policy with users so that users understand what data is being collected and how it is being used.

Cybersecurity

A PricewaterhouseCoopers report describes the cybersecurity threat facing today’s cities:

“With each additional access point, sensitive data exposure vulnerabilities expand. Smart cities can be susceptible to numerous cyber attack techniques, such as remote execution and signal jamming, as well as traditional means, including malware, data manipulation, and DDOS. To counter the risks, comprehensive smart city plans designed to safeguard what is clearly ‘critical infrastructure’ are needed on behalf of all parties involved, from the individual citizen to large public and private institutions.”²⁵

23 City of Kingston, Administrative Code, <https://ecode360.com/13231211>.

24 U.S. Department of Transportation, Federal Highway Administration, “Shared Mobility: Current Practices and Guiding Principles,” Chapter 5, <https://ops.fhwa.dot.gov/publications/fhwahop16022/ch5.htm>.

25 PwC, “Smart cities: five smart steps to cybersecurity,” <https://www.pwc.com/us/en/services/consulting/cybersecurity/library/broader-perspectives/smart-cities.html>.

In addition, PwC recommends five steps for Smart Cities:

1. Create a policy on data privacy and data use
2. Synchronize access credentials across systems
3. Understand the magnitude of the data that will be collected and encrypted
4. Establish access protocols so that only information is shared based on a need to know basis
5. Consequences of cyber-crimes in the Administrative Code should be reviewed and updated to be commensurate with actions taken

The threats to cities are real. A cyberattack crippled the municipal systems in Atlanta.²⁶ Ransomware struck the City of Albany, part of a growing trend of small and mid-size cities and counties revealing their vulnerabilities.²⁷ While the benefits of a connected city are demonstrated in this report, the magnitude of risks are substantial if cybersecurity controls are not well-designed and operating effectively. An audit for Kingston or similar sized cities should be performed to identify the investments needed to maintain information systems that will adequately address cybersecurity risks.

²⁶ Taylor Hatmaker, "The damage from Atlanta's huge cyberattack is even worse than the city first thought," Tech Crunch, June 6, 2018, <https://techcrunch.com/2018/06/06/atlanta-cyberattack-atlanta-information-management/>.

²⁷ Benjamin Freed, "Albany, N.Y. hit with ransomware attack, mayor says," State Scoop, April 1, 2019, <https://statescoop.com/albany-n-y-hit-with-ransomware-attack-mayor-says/>.

APPENDICES

Response from City of Kingston:

“The City of Kingston was briefed on the recommendations of the SIPA Capstone team engaged by NYSERDA. We reviewed the recommendations in the final presentation provided on April 26, 2019 and provided written comments which we are happy for the team to include in their final written report.

All small cities in New York are different, but we feel the SIPA Capstone team has identified several of the challenges that face many cities like ours. The team has also developed several recommendations that have the potential to deliver sustainable mobility.”

Appendix D: Smart Parking Financial Model

Available in attached Excel Spreadsheet

Appendix A: Solutions Evaluation Matrix

Available in attached Excel Spreadsheet

Appendix B: Solutions Shortlist

Available in attached Excel Spreadsheet

Appendix C: City Fleet Financial Model

Available in attached Excel Spreadsheet