

Article

Urban Transit Innovations: A Comparative Study in Canadian Cities

Samuel C. Rankin

Abstract: This paper examines sustainable transportation strategies in Kingston, Vancouver, and Toronto, providing a comparative analysis of how each city integrates sustainable practices into urban planning. It focuses on the electrification of public transit and the implementation of targeted incentives, highlighting how these strategies effectively reduce emissions and enhance urban environments. Through detailed case studies, the research underscores the critical importance of multi-stakeholder commitment from governmental, business, and community sectors. The findings emphasize that successful sustainable transportation requires the adoption of adaptable and comprehensive policies, crucial for promoting sustainable urban mobility.

Keywords: sustainable transportation; electrification of transit; urban planning; policy implementation; green initiatives

1. Introduction

The urgent need for sustainable public transportation has become increasingly apparent in urban development due to escalating environmental pressures. Local governments are actively developing and implementing diverse policies and plans to promote sustainable transit solutions in response to severe environmental challenges facing cities worldwide. This movement is well-represented by the assertion that local authorities are adopting varied strategies and actions to support sustainable transportation.¹

This article explores the significant potential of sustainable transportation systems to transform urban landscapes in Kingston, Vancouver, and Toronto. We provide a comparative analysis of these municipalities, examining their unique transportation strategies as paradigmatic case studies.

Despite growing recognition of their importance, the integration of sustainable practices into the actual planning and redesign of urban infrastructure remains notably sparse in North America. The incorporation of sustainable transportation principles into decisions about street rehabilitation and redesign is still relatively uncommon in this region.²

This analysis argues for an integrated strategy that includes electrification, comprehensive service integration, and targeted incentives to effectively enhance urban environments and robustly respond to climate change. It is imperative for urban transportation planning to shift from a primarily engineering-based focus on vehicular traffic to a more comprehensive, sustainable transport approach. This study highlights the critical components and broader implications of implementing comprehensive sustainable transportation strategies in urban areas by analyzing Kingston's pioneering sustainability initiatives, Vancouver's advanced transit systems, and Toronto's expansion of innovative urban transit solutions.

2. Case Study Analysis

2.1 Kingston, Ontario: Pioneering Sustainability in a Small City

¹ Francis Marleau Donais et al., "Municipal Decision-Making for Sustainable Transportation: Enhancing Practices for Street Rejuvenation in Canada," *Transportation Research* 156 (February 2022), p. 153.

² Donais et al., "Municipal Decision-Making", p. 153.

Kingston, Ontario, exemplifies how small cities can pioneer sustainable transportation initiatives. Kingston, Ontario, exemplifies how small cities can pioneer sustainable transportation initiatives. The city's proactive measures to electrify public transit and taxis highlight its commitment to reducing emissions and improving urban environments. A significant milestone for Kingston has been the doubling of its transit ridership over the past decade, driven by these innovative strategies.³

Kingston's early adoption of electric buses provides a valuable model for sustainable public transit. This initiative has garnered substantial federal and provincial support, reflecting a robust commitment to fostering sustainable solutions in smaller urban areas.⁴ Additionally, Kingston has incentivized taxi operators to transition to hybrid and electric vehicles (EVs), broadening its electrification efforts beyond buses.

These initiatives have produced notable economic and environmental benefits. Environmentally, the switch to electric and hybrid vehicles has significantly reduced greenhouse gas emissions, improving air quality and meeting national standards. Economically, it has spurred job creation in renewable energy and transportation technology maintenance, showcasing the dual benefits of such initiatives.⁵

Kingston's approach not only demonstrates the effectiveness of localized sustainable transportation initiatives but also their potential as scalable models for broader urban sustainability efforts. By integrating advanced electrification technologies and designing targeted incentives, Kingston has significantly enhanced its urban environment and provided a replicable framework for other cities. Its success contributes to the broader dialogue on sustainable urban development, underscoring the need for comprehensive strategies that tackle the complex challenges of climate change. Through dedicated implementation of these measures, Kingston showcases how sustainable transportation can drive substantial environmental and economic gains, paving the way for a more sustainable future in urban centers globally.



Figure 1. Kingston's new fleet of electric buses highlights the city's proactive measures to embrace sustainable transportation.⁶

³ Preston L. Schiller, "Mobility for All: How Kingston Doubled Its Transit Ridership within 10 Years," *Plan Canada*, 2019, p. 15.

⁴ Catherine McKenna et al., "Canada and Ontario Invest in Sustainable Public Transit and Active Transportation Infrastructure for Kingston Residents," *Canada NewsWire*, August 10, 2020, p. 1.

⁵ Megan MacCallum et al., "Renewable Energy, Sustainable Jobs: The Case of the Kingston, Ontario, Region," in *Work in a Warming World* (Kingston: McGill-Queen's University Press, 2015), Pp. 216–217.

⁶ Kimberley Johnson, "Kingston Transit Adds Two New Fully Electric Buses to Fleet," *CTV News Ottawa*, July 29, 2021.

2.2 Vancouver, British Columbia: Advancing Transit Systems

Vancouver, British Columbia, stands out in the development of transit systems, particularly through the electrification and integration of its transportation infrastructure, which are key facets of the sustainable transportation strategy emphasized by this research. TransLink, the city's transit authority, has played a pivotal role by deploying electric and trolley buses, significantly reducing urban carbon emissions. Furthermore, Vancouver has integrated "Green Mode" options into ridesharing apps, encouraging users to opt for environmentally friendly transport methods. This aligns with global trends where e-bikes, as one of the fastest-growing segments in transportation, are poised to accelerate the shift towards low-carbon mobility.⁷

The strategic integration of technology and innovative solutions in Vancouver enhances urban sustainability. The inclusion of EVs in the public transit fleet has reduced reliance on fossil fuels and modernized urban mobility in line with sustainability policies. Additionally, collaborations between the city and academic institutions have underscored the significant role of research in refining urban sustainability practices.⁸

Evidence shows that Vancouver's transit systems have markedly improved urban congestion and sustainability, with substantial gains in efficiency and usage. Enhanced public transportation systems substantiate claims that such systems can alleviate congestion and pollution by reducing the number of private vehicles. These changes provide direct benefits like expanded public transport options, and indirect benefits, including mitigating the urban heat island effect and reducing greenhouse gas emissions.⁹

Vancouver's comprehensive approach serves as a pivotal case study in this research, underscoring the importance of integrating electrification, comprehensive service integration, and targeted incentives into urban transportation strategies. The city's initiatives exemplify effective strategies for tackling urban environmental challenges and climate change. Vancouver demonstrates how urban areas can improve their environmental, economic, and social landscapes through strategic planning and the adoption of advanced technologies. These achievements position Vancouver as a model for other cities aiming for sustainable outcomes, emphasizing the importance of strategic vision and the implementation of integrated transportation strategies that prioritize resource efficiency and technological innovation.

⁷ Sara Edge, Joshua Goodfield, and Jennifer Dean, "Shifting Gears on Sustainable Transport Transitions: Stakeholder Perspectives on E-Bikes in Toronto, Canada," *Environmental Innovation and Societal Transitions* 36 (September 2020), p. 197.

⁸ Stefan U. Pauer, Angelique Pilon, and Brad Badelt, "Strengthening City–University Partnerships to Advance Sustainability Solutions: A Study of Research Collaborations between the University of British Columbia and City of Vancouver," *International Journal of Sustainability in Higher Education* 21, no. 6 (July 23, 2020), p. 1190.

⁹ Ahmad Alkharabsheh et al., "An Integrated Approach of Multi-Criteria Decision-Making and Grey Theory for Evaluating Urban Public Transportation Systems," *Sustainability* 13, no. 5 (March 3, 2021), p 1.



Figure 2. Trolleybuses operate along a busy street in Vancouver, reflecting the city's advanced integration of electric public transportation.¹⁰

2.3 Toronto, Ontario: Scaling Up Innovations in Urban Transit

Toronto, Ontario, stands as a pioneer in scaling up urban transit innovations, with a strong commitment to the widespread electrification of public transportation and the promotion of green transit practices. These efforts are crucial for mitigating climate change and improving urban environments. The Toronto Transit Commission (TTC) has launched a bold initiative to electrify its public transit network, with the introduction and expansion of electric buses as a cornerstone. These buses are celebrated as one of the most significant sustainable solutions in mass transit history, noted for their potential to drastically cut emissions and improve urban air quality.¹¹

Table 1. Projected Electric Bus Procurement and Funding Timeline for Toronto (TTC)¹²

| | 2018-2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034-2040 | Total |
|-----------------|-----------|------|------|------|------|------|------|------|------|------|------|------|-----------|-------|
| Funded | 60 | – | 50 | 290 | – | – | – | – | – | – | – | – | – | 400 |
| Unfunded | – | – | – | 60 | 170 | 175 | 175 | 165 | 190 | 190 | 190 | 195 | 1,365 | 2,875 |

Toronto is actively expanding its electric bus fleet as a pivotal element of its broader public transit modernization strategy. The city's eBus Procurement Plan ambitiously aims to introduce a total of 2,875 electric buses by 2040. This initiative kicked off with the deployment of 60 eBuses in 2019 and is set to expand

¹⁰ Graeme Wood, "Canada to Extend Life of Metro Vancouver Electric Trolley Buses," *Vancouver Is Awesome*, December 12, 2023.

¹¹ Thomas Abdallah, "The Sustainable Mass Transit Revolution," in *Sustainable Mass Transit Challenges and Opportunities in Urban Public Transportation*, 2nd ed. (Amsterdam, NL: Elsevier, 2023), p. 1.

¹² TTC, "TTC Role under Transformation TO," *Bus Electrification Plan* (Toronto, ON: Toronto Transit Commission (TTC), December 7, 2023).

significantly with a contract for 340 additional buses by 2023. These efforts underscore Toronto's commitment to slashing urban emissions and transitioning to a fully electrified public transport network. The plan not only marks a significant step towards sustainable urban mobility but also paves the way for broader environmental improvements within the city.

In addition to its bus electrification efforts, Toronto has implemented the Smart Commute initiative, aimed at reducing dependence on private vehicles and incorporating a variety of eco-friendly transportation modes. This initiative plays a critical role in reducing urban congestion and pollution, and in enhancing the efficiency of the commuter network. Moreover, Toronto has embraced micro-transit solutions to provide crucial first- and last-mile connectivity, offering flexible, demand-responsive transit options that augment the public transit system. This approach is particularly valuable as micro-transit has proven effective in linking suburban and rural areas with major employment centers and services, facilitating comprehensive urban mobility.¹³

These initiatives also hold the potential to attract tourists and promote sustainable mobility at tourist destinations, influencing both public transportation use and the development of soft mobility, thereby extending their impact beyond daily commuters to transient populations.¹⁴

Toronto's modernization of public transit is characterized by robust public engagement, including community consultations and information campaigns that ensure developments align with the preferences and needs of city residents. This inclusive approach has not only fostered broader acceptance and use of green transit solutions but has also garnered significant public support, essential for the long-term sustainability of these initiatives.



Figure 3. Electric buses at a Toronto Transit Commission (TTC) charging station, equipped with overhead pantograph chargers.¹⁵

3. Comparative Analysis and Implications

¹³ Eleni Bardaka et al., "Reimagining Ride Sharing: Efficient, Equitable, Sustainable Public Microtransit," *IEEE Internet Computing* 24, no. 5 (September 1, 2020), p. 39.

¹⁴ Carlos Rosa-Jiménez et al., "Relating Spatial Quality of Public Transportation and the Most Visited Museums: Revisiting Sustainable Mobility of Waterfronts and Historic Centers in International Cruise Destinations," *Sustainability* 15, no. 3 (January 21, 2023), p. 1.

¹⁵ Anthony Capkun, "PowerON and TTC Unveil New Electric Bus Charging Pantographs," *Electrical Business*, April 27, 2023.

This comparative analysis synthesizes findings from Kingston, Vancouver, and Toronto, offering a nuanced perspective on the successes and challenges of implementing sustainable transportation strategies within these unique urban contexts. Each city demonstrates the adaptability and essential nature of integrated strategies that incorporate electrification, comprehensive service integration, and targeted incentives.

Kingston's early adoption of electric buses and taxis highlights the critical role of focused governmental incentives and robust public-private partnerships in promoting sustainability in smaller urban areas. These localized, focused endeavours effectively establish sustainability benchmarks. Conversely, Vancouver's sophisticated transit systems, including electric and trolley buses and innovative 'Green Mode' rideshare options, exemplify the efficacy of integrating various public transit modes to significantly reduce urban congestion and emissions. Toronto's Smart Commute program and extensive electrification initiatives show how larger urban areas can enhance public transit accessibility and reduce carbon footprints through policy and technology.

These cities have seen notable reductions in greenhouse gas emissions, marked improvements in urban air quality, and increases in public transit ridership, contributing to the global movement toward low-carbon urban environments. However, each faces distinct challenges: Toronto grapples with coordinating extensive infrastructure changes across its vast metropolitan landscape, Vancouver struggles with maintaining funding for its transit innovations, and Kingston's limited size restricts its scalability.

From these case studies, several global lessons emerge. Kingston's success underlines the importance of customizing governmental incentives to meet the specific needs and scales of urban areas. Vancouver's technological implementations in public transit provide a replicable model for other cities aiming to enhance the efficiency and appeal of their systems. Toronto's experience underscores the necessity of community involvement for the acceptance and success of extensive transportation projects.

Policymakers worldwide should consider the unique requirements of their urban environments and the accomplishments of these cities when developing sustainable transportation strategies. Policies should promote the adoption of electric vehicles in both public and private sectors through financial incentives, regulatory support, and infrastructure investments. The enhancement of public-private partnerships, as demonstrated by Kingston, can accelerate the deployment of sustainable technologies and practices. Furthermore, integrating technological advancements like mobile app-based rideshare options can increase the accessibility and appeal of sustainable alternatives.

The contributions of companies such as Uber and Bird to sustainable urban mobility also merit attention. By offering incentives for choosing green-certified vehicles, such as hybrids or fully electric models, these companies facilitate the transition to more sustainable transportation. Promotions for environmentally friendly travel options not only reduce emissions but also foster a cultural shift towards environmental awareness among urban commuters.

The comparative analysis of Kingston, Vancouver, and Toronto underscores that despite diverse challenges, the overarching benefits of enhanced public health, reduced emissions, and improved urban livability are compelling. The successful implementation of these strategies depends on the strategic use of technology, the adaptability of policies to local contexts, and the active involvement of both the public and private sectors in developing a sustainable transit ecosystem.

4. Conclusions

This investigation vividly underscores the critical importance of integrating sustainable transportation frameworks into urban planning to effectively address the severe challenges posed by environmental degradation and climate change. The comprehensive case studies of Kingston, Vancouver, and Toronto highlight a clear trend toward adopting sustainable transportation paradigms, demonstrating the feasibility and benefits of such strategies. Despite notable progress, the integration of these practices into broader urban development strategies remains insufficiently rigorous.

Kingston, Vancouver, and Toronto have each made significant advances in implementing sustainability initiatives. However, according to our comparative analysis, the full implementation of strategies that include strategic incentives, electrification, and service integration is still nascent. The successes of these cities provide a blueprint for other municipalities to follow as they pursue similar sustainable paths. While these strategies have proven effective, their success hinges on a unified commitment from all stakeholders, including governments, businesses, and citizens.

Furthermore, fostering a cultural and behavioural shift towards sustainability necessitates a steadfast dedication to public engagement and education, alongside significant technological and infrastructural investments. Such multifaceted strategies are crucial for transforming urban transportation into sustainable systems.

This article has highlighted the persistent obstacles and articulated the essential strategies required for this transformative journey. Urban centers worldwide must adopt and refine these methodologies as they deepen their understanding of the intricate relationship between environmental resilience and sustainable transportation. Achieving the dual objectives of meaningful climate mitigation and the enhancement of urban life is only possible through a collaborative and committed effort.

Appendix: Supplementary Data and Visuals

Table 1. Projected Electric Bus Procurement and Funding Timeline for Toronto (TTC)

| | 2018-2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034-2040 | Total |
|-----------------|-----------|------|------|------|------|------|------|------|------|------|------|------|-----------|-------|
| Funded | 60 | – | 50 | 290 | – | – | – | – | – | – | – | – | – | 400 |
| Unfunded | – | – | – | 60 | 170 | 175 | 175 | 165 | 190 | 190 | 190 | 195 | 1,365 | 2,875 |

This table details the projected increment in the number of electric buses from 2018 to 2040 within Toronto's public transit system. It shows both the funded and unfunded segments, illustrating strategic steps toward a fully electrified fleet in response to urban sustainability goals and climate change mitigation efforts.

Figure 1: Kingston's New Fleet of Electric Buses



This image displays Kingston's new fleet of electric buses, emphasizing the city's commitment to sustainable transportation. Located in a downtown setting, these buses symbolize a significant move towards reducing urban emissions and achieving a transition to 100% electric public transit.

Figure 2: Trolleybuses Operating in Vancouver



Here, trolleybuses are seen navigating a busy street in Vancouver, showcasing the city's progressive integration of electric public transportation. As vital elements of Vancouver's sustainable transit system, these trolleybuses play a crucial role in alleviating urban congestion and reducing greenhouse gas emissions, aligning with the city's objectives for green mobility.

Figure 3: Electric Buses at a Toronto Transit Commission (TTC) Charging Station



This photograph captures electric buses at a TTC charging station, complete with overhead pantograph chargers. It highlights the TTC's dedication to enlarging its electric bus fleet as an integral part of Toronto's strategy for sustainable urban transit. The deployment of advanced charging infrastructure underscores the city's active efforts to diminish carbon emissions and boost the efficiency of its public transportation systems.

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