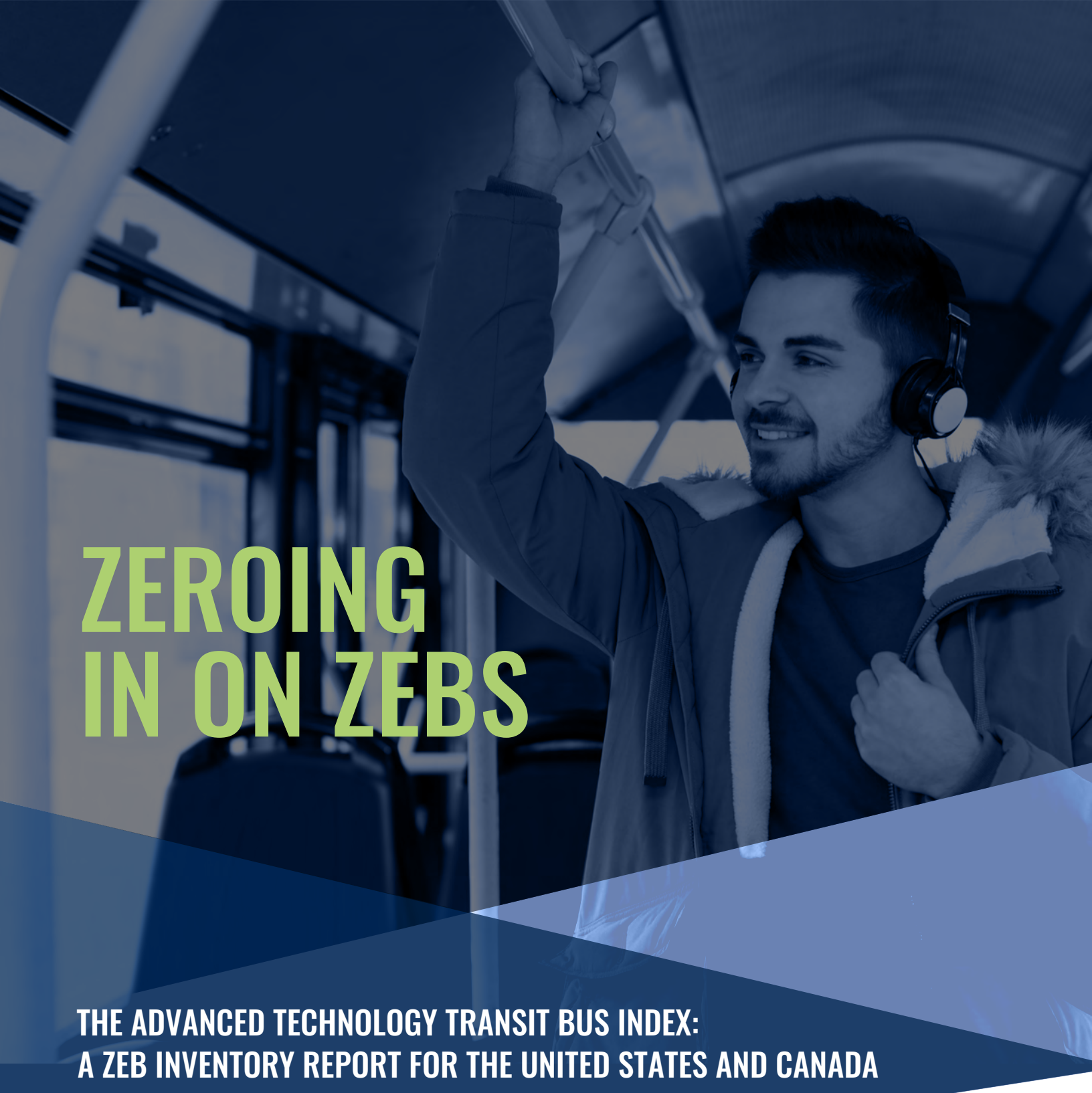

ZEROING IN ON ZEBS

THE ADVANCED TECHNOLOGY TRANSIT BUS INDEX: A ZEB INVENTORY REPORT FOR THE UNITED STATES AND CANADA

February 2023

A CALSTART Report
By Rachel Chard, Mike Hynes,
Bryan Lee, and Jared Schnader
www.calstart.org

Dedication

CALSTART would like to dedicate this year's *Zeroing in on ZEBs* report to Fred Silver, our long-time Bus Initiative leader. This paper was conceived and overseen by Fred since its inception. He was a pioneer in the transit industry and brought monumental programs to fruition, including the American Fuel Cell Challenge and the first prototype of a battery-electric bus. There can be no better homage to Fred's legacy than to map the growth of the industry he was pivotal in helping create. Thank you, Fred, for your dedication to CALSTART and our members, and for your tireless efforts to advance clean transportation technology.

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Any errors are the authors' own.

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This report was revised and reissued on February 2, 2023, to reflect correct tables in Appendix A.

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List of Acronyms

Acronym	Definition
BEB	battery-electric bus
CARB	California Air Resources Board
CIB	Canadian Infrastructure Bank
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CUTRIC	Canadian Urban Transit Research & Innovation Consortium
EVID	Electric Vehicle Infrastructure Demonstration Program
FCEB	fuel cell electric bus
FTA	Federal Transit Administration
Global MOU	Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
ICT	Innovative Clean Transit (regulation)
IIJA	Infrastructure Investment and Jobs Act
Low-No	Low or No Emission Bus Program
MHDV	medium- and heavy-duty vehicle
NYSERDA	New York State Energy Research and Development Authority
NYTVIP	New York Truck Voucher Incentive Program
ZEB	zero-emission bus
ZETF	Zero Emission Transit Fund

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Executive Summary

This report provides an updated inventory of adopted zero-emission buses (ZEBs)—defined as Class 3 and above battery-electric or fuel cell electric transit buses—that have been funded, ordered, and/or delivered within the United States and Canada, according to data collected through September 2022. ZEB adoptions continue to steadily increase year-over-year as transit operators take advantage of advances in zero-emission technology and available funding sources. In the United States, the count of full-size ZEBs has grown to 5,480—a 66% increase since 2021. In Canada, the total number of ZEBs has grown to 859, including 219 new full-size buses counted this year.

In the United States, the count of full-size zero-emission transit buses has grown to 5,480—a 66% increase since 2021.

Looking across the United States, California remains the state with the most ZEBs adopted, while numerous other states doubled their count in the last year, including Arizona, Massachusetts, Vermont, and Maine. Arizona and Massachusetts saw the largest year-over-year increases at 280% and 271%, respectively.

Fuel cell electric buses, while still vastly outnumbered by battery-electric buses, continue to gain traction with a 64% increase in adoption since the 2021 count. The footprint of small ZEBs has also expanded. The number of small ZEBs in the United States grew by 261 from 2021, representing a 42% increase. Transit agencies in Florida, Hawaii, Illinois, New York, and Oregon purchased small ZEBs for the first time.

Fuel cell electric buses, while still vastly outnumbered by battery-electric buses, continue to gain traction in the United States, with a 64% increase in adoption since 2021.

Since President Biden signed the Infrastructure Investment and Jobs Act into law in November of 2021, historic levels of funding have been made available for zero-emission transit projects. In 2022, more than $1.6 billion was allocated through the Federal Transit Administration's (FTA's) Low and No Emission Grants and the Bus and Bus Facilities Grants; this funding supported investment in 150 transit fleets and facilities throughout the United States with more than 1,100 vehicles being zero-emission (FTA, 2022). In August 2021, the Canadian government announced the creation of the Zero Emission Transit Fund, which will allocate $2.75 billion to ZEBs over five years with a goal of deploying 5,000 ZEBs (Government of Canada, 2021).

I. Introduction and Background

Since the creation of the Clean Air Act, the U.S. government has worked with public and private organizations to reduce the amount of pollution released into the atmosphere. Transit buses have historically and predominantly operated on diesel fuel. Although buses produce less smog per capita than cars, they still release toxic fumes such as nitrogen oxides directly into communities.

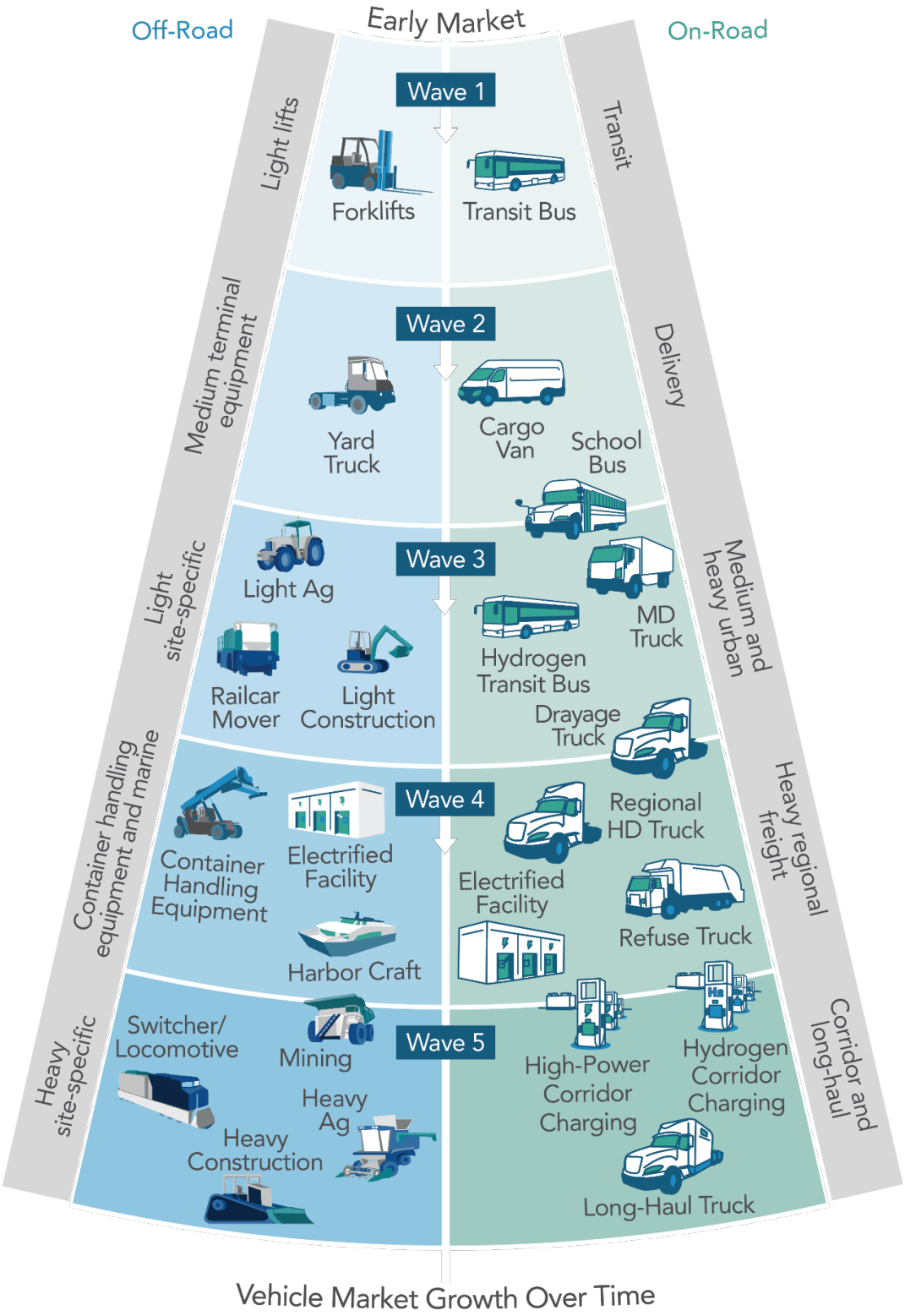
Between 2013 and 2021, the Federal Transit Administration (FTA) distributed over $664 million for hybrid, compressed natural gas, battery-electric, and hydrogen fuel cell electric buses via the Low or No Emission Bus (Low-No) Program. In 2022, the Low-No Program saw a significant boost in funding with the passage of the Infrastructure Investment and Jobs Act (IIJA). The $5.5 billion allocated for Low-No was six times greater than the funding provided in the previous five years of the program (FTA, 2022). State-level grant programs, such as California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) and the Transit and Intercity Rail Capital Program as well as New York's Truck Voucher Incentive Program (NYTVIP), have also supported the adoption of zero-emission buses (ZEBs) for transit. Additionally, money from the 2016 Volkswagen Clean Air Act Civil Settlement was made available to states to purchase zero-emission vehicles.

Over the last decade, ZEB adoptions have steadily increased across the United States and Canada. The number of ZEBs purchased by transit agencies, universities, and private entities has continued to grow as these organizations take advantage of the expanding number of vehicle models available and the advancements in battery-electric and fuel cell electric technologies. Quantifying this increase is a challenge that was first undertaken by CALSTART in 2018 with the release of the inaugural *Zeroing in on ZEBs* report. CALSTART has updated this data annually in subsequent editions of *Zeroing in on ZEBs*, and the report has proven to be the definitive resource for those seeking up-to-date counts of ZEBs across the United States and Canada.

Tracking this data comprehensively throughout the United States and Canada is an important exercise because it offers context to the two countries' progress toward adopting this critical technology. As a broader view, **Figure 1** below is the most recent update of the zero-emission beachhead strategy, which was developed by CALSTART in partnership with the California Air Resources Board (CARB) to trace zero-emission technology adoption progress across different types of commercial vehicles, including buses. ZEBs are a foundational commercial vehicle market segment where zero-emission

and near zero-emission technologies are most likely to succeed first and can also contribute to the development of vehicles in other segments.

Figure 1: The Zero-Emission Beachhead (CARB, 2022)



This report quantifies the adoption of ZEBs by technology: battery-electric buses (BEBs) and fuel cell electric buses (FCEBs). The data for this report is current as of September 2022 and was gathered primarily through local, state, and federal award documents; press releases; email communication; and phone interviews. The data captured was also validated using sales information from bus manufacturers.

It is important to note that this edition of the report does not quantify the number of deployed buses as has been shown in years past. As indicated in previous years' reports, there is no centralized accounting of ZEBs, and transit agencies' plans for adoption can shift and/or be delayed. Such variances have only been exacerbated by the COVID-19 pandemic as agencies have had to shift plans and resources, delay or cancel orders, and adjust due to issues in the supply chain. CALSTART hopes to provide this information again in future years as we work to improve our tracking process for ZEBs moving through the stages of adoption. Furthermore, the figures in this report should not be considered static. This report defines the **adoption** of transit ZEBs as those that have been funded, ordered, or delivered:

- **Funded:** Funding to support the procurement of the ZEB has been officially awarded.
- **Ordered:** The transit provider has submitted an order for the ZEB.
- **Delivered:** The ZEB has been received by the transit provider and is being prepared to be placed into operational service.

II. U.S. Full-Size ZEB Count

Full-size ZEBs—defined as Class 7 or 8 transit buses that are 30 or more feet in length—have grown nationally to 5,480 on the road, awarded, or on order, an increase of 66% since the 2021 count (**Table 1**). Led by California, the West Coast, including Oregon and Washington, accounts for 41% of all ZEBs nationwide. California, a state where all new sales of transit buses must be zero-emission by 2030 according to the Innovative Clean Transit (ICT) regulation, has the highest number of ZEBs with 1,977.

Table 1: U.S. Full-Size Transit ZEBs Year-Over-Year Growth

Bus Type	2021	2022	Increase (2021 to 2022)	Growth %
BEB	3,168	5,269	2,101	**66%**
FCEB	129	211	82	**64%**
Total ZEBs	**3,297**	**5,480**	**2,183**	**66%**

BEBs remain the most common form of ZEB on the road compared to FCEBs. This disparity can be attributed to a variety of factors including cost, infrastructure, and owner or operator preference. The market share of FCEBs has continued to grow year-over-year and will increase as transit agencies look to account for extended routes or other operational needs that can be better met by FCEBs.

Figure 2 provides a breakdown of the number of full-size ZEBs per state. **Table 2** further disaggregates this data and provides a state-by-state breakdown of the number of BEBs and FCEBs adopted.

Figure 2: Full-Size Transit ZEBs Funded, Ordered, or Delivered Within the United States (Updated September 2022)

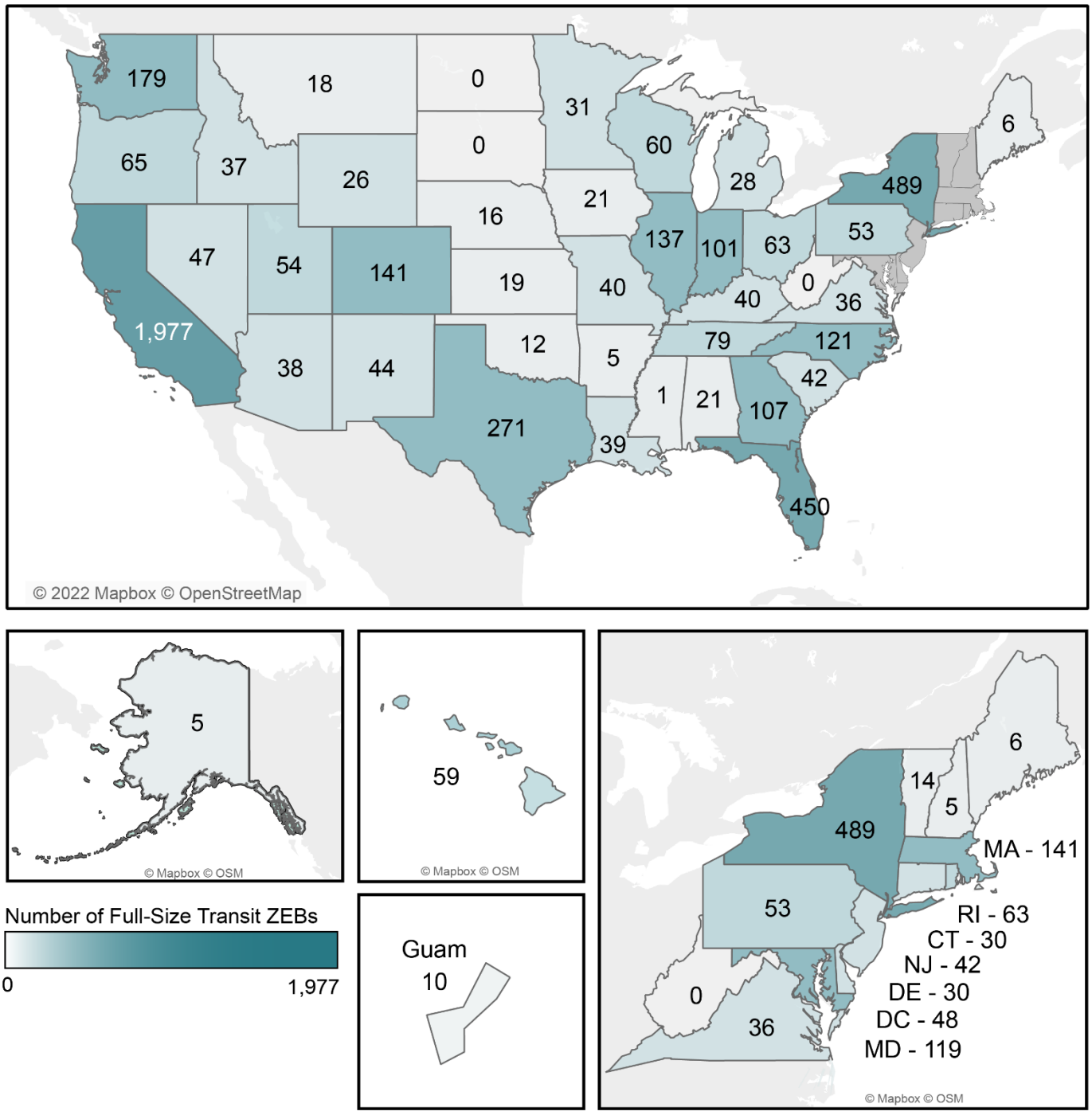


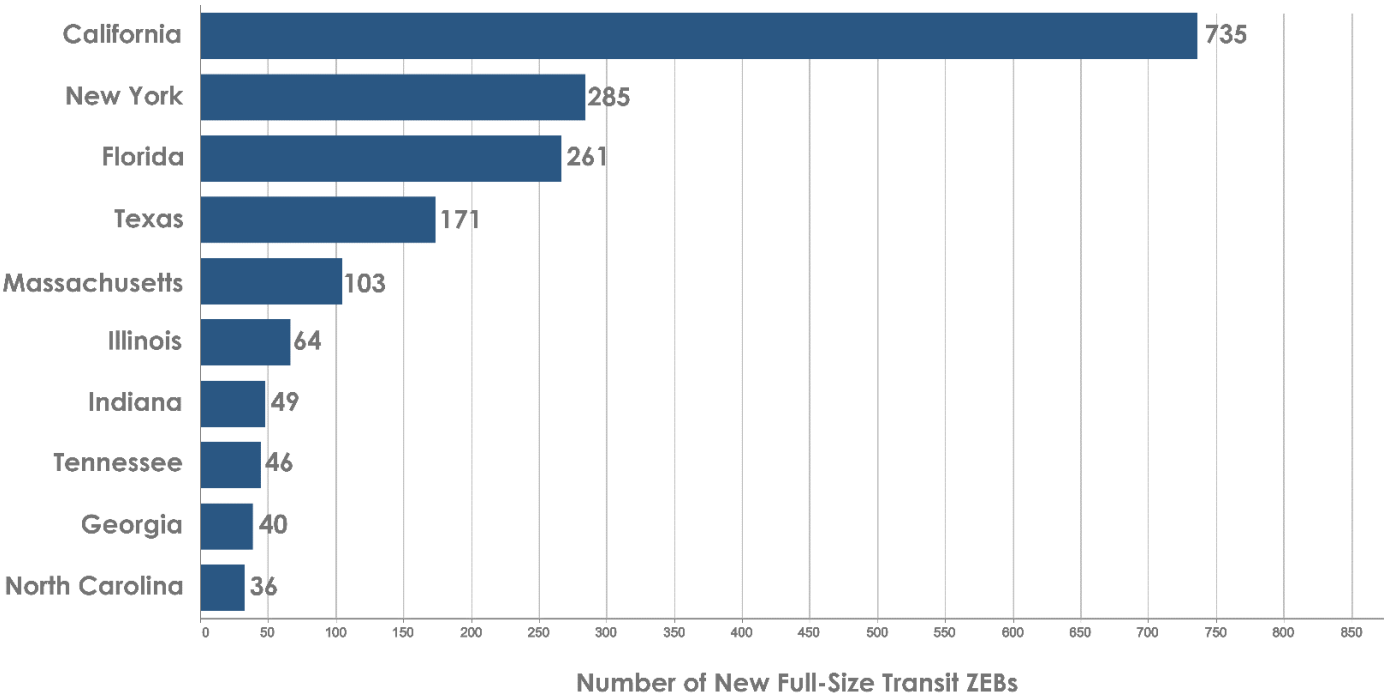
Table 2: State-By-State Full-Size Transit ZEB Distribution (Updated September 2022)

State		FTA Region	BEBs	FCEBs	Total ZEBs
Alabama	AL	4	20	1	21
Alaska	AK	10	5	0	5
Arizona	AZ	9	26	12	38
Arkansas	AR	6	5	0	5
California	CA	9	1,841	136	1,977
Colorado	CO	8	141	0	141
Connecticut	CT	1	30	0	30
Delaware	DE	3	28	2	30
District of Columbia	DC	3	48	0	48
Florida	FL	4	450	0	450
Georgia	GA	4	107	0	107
Hawaii	HI	9	52	7	59
Idaho	ID	10	37	0	37
Illinois	IL	5	135	2	137
Indiana	IN	5	101	0	101
Iowa	IA	7	21	0	21
Kansas	KS	7	19	0	19
Kentucky	KY	4	40	0	40
Louisiana	LA	6	39	0	39
Maine	ME	1	6	0	6
Maryland	MD	3	106	13	119
Massachusetts	MA	1	138	3	141
Michigan	MI	5	24	4	28
Minnesota	MN	5	31	0	31
Mississippi	MS	4	1	0	1
Missouri	MO	7	40	0	40
Montana	MT	8	18	0	18
Nebraska	NE	7	16	0	16

State		FTA Region	BEBs	FCEBs	Total ZEBs
Nevada	NV	9	41	6	47
New Hampshire	NH	1	5	0	5
New Jersey	NJ	2	42	0	42
New Mexico	NM	6	44	0	44
New York	NY	2	484	5	489
North Carolina	NC	4	121	0	121
North Dakota	ND	8	0	0	0
Ohio	OH	5	50	13	63
Oklahoma	OK	6	12	0	12
Oregon	OR	10	65	0	65
Pennsylvania	PA	3	53	0	53
Rhode Island	RI	1	63	0	63
South Carolina	SC	4	42	0	42
South Dakota	SD	8	0	0	0
Tennessee	TN	4	79	0	79
Texas	TX	6	266	5	271
Utah	UT	8	54	0	54
Vermont	VT	1	14	0	14
Virginia	VA	3	36	0	36
Washington	WA	10	177	2	179
West Virginia	WV	3	0	0	0
Wisconsin	WI	5	60	0	60
Wyoming	WY	8	26	0	26
Guam	GU	9	10	0	10
Total	-	-	**5,269**	**211**	**5,480**

Growth occurred in every FTA region but one in the past year. The region with the highest growth rate was Region 6—Arkansas, Louisiana, New Mexico, Oklahoma, and Texas—with a growth rate of 129% compared to 2021. Texas saw a strong increase in adoption, with multiple Low-No awards totaling more than $77 million and the number of full-size ZEBs rising from 100 in 2021 to 271 in 2022. Region 1 was awarded nearly $144 million in fiscal year 2022 Low-No funds, with the Massachusetts Bay Transportation Authority accounting for $116 million of the total $144 million. The region with the lowest growth rate was Region 10 in the Pacific Northwest and Alaska. For detailed information on growth per FTA region, refer to Appendix A. **Figure 3** highlights the 10 states with the largest numerical increases in full-size ZEB adoption since the previous count.

Figure 3: Top 10 States with Largest Numerical Increases in Full-Size Transit ZEB Adoption (Compared to 2021)

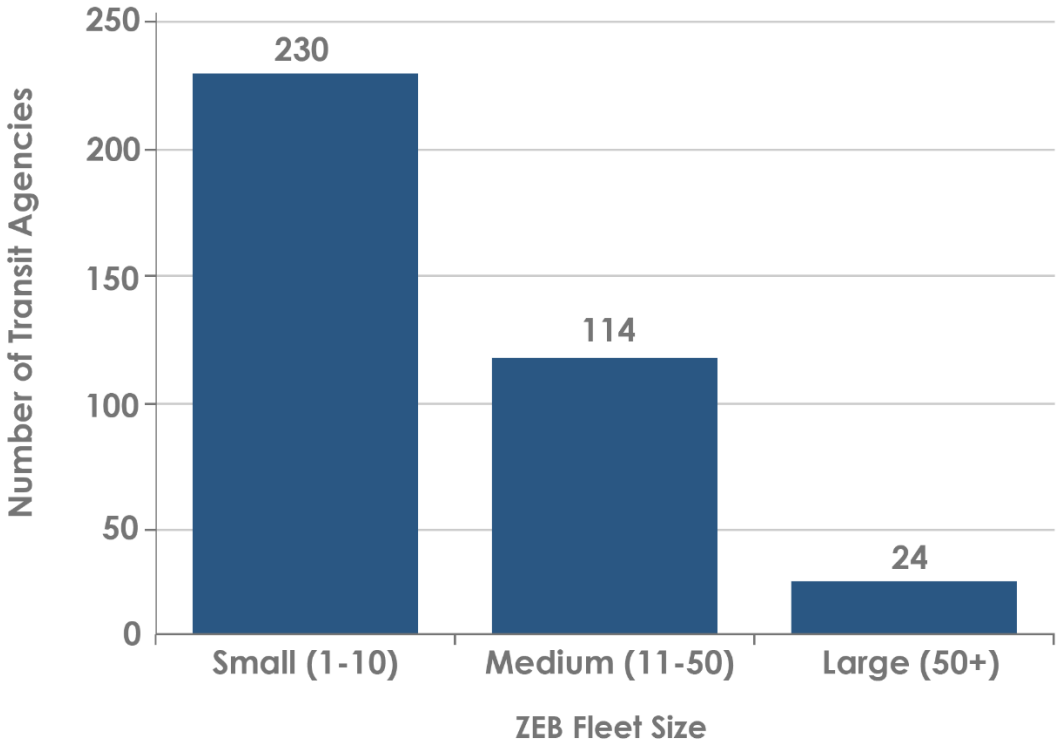


The median number of full-size ZEBs per transit agency nationwide was five for 2022 (and for 2021). As of September 2022, the Los Angeles Metropolitan Transportation Authority has the largest full-size ZEB fleet with 566 BEBs. The Alameda-Contra Costa Transit District, also in California, has the largest full-size FCEB fleet with 23 buses.

Around 63% of fleets in the United States have 10 or fewer full-size ZEBs (**Figure 4**). This number demonstrates that most fleets are still operating a small number of ZEBs and have not yet reached scale. The current distribution of ZEBs by fleet size is very similar to 2021, which indicates that fleets are having difficulty getting to scale. While the number of ZEBs across large transit fleets has increased, most ZEB fleets remain small. There is still a great need for more effort and resources to be devoted to helping smaller fleets overcome barriers to adoption.

California leads the nation with the most full-size ZEB adoptions and adoptions of the largest scale. Despite this achievement, California is still on the same trajectory with the rest of the United States: the majority of the state's transit agencies have fewer than 10 ZEBs. California will also need to provide resources to help scale up its smaller fleets.

Figure 4: Distribution of Full-Size Transit ZEB Fleet Size in the United States (Updated September 2022)



Fuel Cell Electric Buses

Adoption of full-size FCEBs in the Unites States has increased by 64% since the 2021 count (**Table 3**). While California continues to lead the country in the number of FCEBs adopted, there are now 14 states with transit agencies that have adopted FCEBs. Arizona, Delaware, Maryland, and New York adopted their first FCEBs in 2022, and the number of states with 10 or more FCEBs doubled, growing from two states in 2021 to four in 2022.

Table 3: U.S. Full-Size Transit FCEBs Year-Over-Year Growth

State	2021 Totals	2022 Totals	Difference (2021 to 2022)
Alabama	1	1	0
Arizona	0	12	12
California	99	136	37
Delaware	0	2	2
Hawaii	1	7	6
Illinois	2	2	0
Maryland	0	13	13
Massachusetts	3	3	0
Michigan	2	4	2
New York	0	5	5
Nevada	2	6	4
Ohio[1]	12	13	1
Texas	5	5	0
Washington	2	2	0
Total	**129**	**211**	**82**

[1] The 2021 total number for Ohio has been updated from the December 2021 edition of this report.

III. U.S. Small ZEB Count

Small ZEBs—defined as transit buses that are Class 3–6 and shorter than 30 feet—remain an established technology in fleets. While most efforts to electrify fleets have focused on Class 7–8 buses, small buses comprise a significant proportion of transit vehicles in use today. According to the FTA's National Transit Database 2021 Vehicles Data Table, there are nearly as many small buses in service as there are 40- and 60-foot buses (FTA, 2021).

Traditionally, transit agencies have utilized small buses to provide demand-response service for senior citizens and people with impairments. Today, however, transit agencies seek to boost ridership by providing the public with additional services such as on-demand response and connections for first/last-mile journeys; these offerings are optimal for small bus applications. The transition to ZEBs is not limited to full-size buses. As transit providers modernize their fleets and aim to make transit cleaner, more efficient, and dependable, the demand for small ZEBs has grown. Today, both small BEB and FCEB options are available on the market.

As of September 2022, 876 small ZEBs have been adopted in the Unites States. This figure, which includes small ZEBs adopted by public transit agencies, private fleets, and airports, grew by 261 from 2021—an overall increase of 42% year-over-year, though the growth rate is 31% less than the rate recorded in 2021. (See **Table 4** for a breakdown of small ZEBs' year-over-year growth and **Table 5** for state-by-state small ZEB distribution.) Based on the data collected, no new small FCEBs were purchased over the last year. The count of new small BEBs purchased by public agencies increased by 219, representing a 106% growth from 2021. There are now 100 public transit agencies with small ZEBs. Of the 100, 18 public agencies purchased their first small ZEBs in 2022. Private companies, including three first-time buyers of ZEBs, purchased 14 small ZEBs in 2022. Small ZEBs adopted by airports and airport parking companies increased from 114 in 2021 to 142 in 2022, a growth of 25%.

Table 4: U.S. Small Transit ZEBs Year-Over-Year Growth

Bus Type	2021	2022	Increase (2021 to 2022)	Growth %
Public BEB	198	417	219	111%
Public FCEB	9	9	0	0%
Public Total	**207**	**426**	**219**	**106%**
Private BEB	284	298	14	5%
Private FCEB	0	0	0	0%
Private Total	**284**	**298**	**14**	**5%**
Airport BEB	114	142	28	25%
Airport FCEB	0	0	0	0%
Airport Total	**114**	**142**	**28**	**25%**
University BEB	10	10	0	0%
University FCEB	0	0	0	0%
University Total	**10**	**10**	**0**	**0%**
Total ZEBs	**615**	**876**	**261**	**42%**

Transit agencies in Florida, Hawaii, Illinois, Indiana, Kansas, Missouri, New York, and Oregon purchased their first small ZEBs in 2022. Other states had substantial increases in small ZEB adoptions since the 2021 count. For example, Sun Metro in El Paso, Texas, moved forward with a plan to procure and deploy 50 small buses, and Iowa's count between 2021 and 2022 more than doubled.

The majority of small ZEBs remain battery-electric. The nine small FCEBs counted in California and Ohio did not change from 2021. All small FCEBs that have been adopted reside with public agencies.

Table 5: State-By-State Small Transit ZEBs Distribution (Updated September 2022)

State		FTA Region	BEBs	FCEBs	Total ZEBs
Arizona	AZ	9	11	0	11
California	CA	9	586	4	590
Colorado	CO	8	8	0	8
Connecticut	CT	1	0	0	0
Florida	FL	4	5	0	5
Georgia	GA	4	3	0	3
Hawaii	HI	9	4	0	4
Iowa	IA	7	32	0	32
Illinois	IL	5	10	0	10
Indiana	IN	5	2	0	2
Louisiana	LA	6	0	0	0
Kansas	KS	7	12	0	12
Maryland	MD	3	5	0	5
Michigan	MI	5	28	0	28
Minnesota	MN	5	23	0	23
Missouri	MO	7	14	0	14
New Mexico	NM	6	7	0	7
Nevada	NV	9	0	0	0
New Jersey	NJ	2	0	0	0
New York	NY	2	4	0	4
Ohio	OH	5	15	5	20
Oregon	OR	10	12	0	12
Texas	TX	6	56	0	56
Vermont	VT	1	12	0	12
Washington	WA	10	4	0	4
Wisconsin	WI	5	14	0	14
Total	-	-	**867**	**9**	**876**

IV. U.S. Airport ZEB Count

The number of ZEBs in service at U.S. airports continues to grow. In addition to other federal programs, airports can take advantage of airport-specific programs such as the Airport Zero Emission Vehicle and Infrastructure Pilot Program. This program, created in 2021, provides grants for airport-owned ZEBs. In 2022, the Federal Aviation Administration awarded over $27 million to assist more than a dozen airports in purchasing ZEBs (Federal Aviation Administration, 2022). ZEBs in service at airports are typically used as "people movers" to transport airline passengers from parking lots to the airport terminal and back. Many private companies that operate off-site parking lots have also adopted ZEBs to transport airline passengers to and from the airport.

As of September 2022, the number of airport ZEBs in the United States has grown to 151 full-size ZEBs, all of which are battery-electric, and 142 small ZEBs (see **Table 6** for state-by-state distribution). Of this total, 51 new full-size and small ZEBs were adopted in 2022, representing an overall 25% growth from 2021. It is important to note that the airport small ZEBs reported in this section were also included in the overall small ZEBs count (refer to **Section III. U.S. Small ZEB Count**).

The majority of airport ZEB adoptions remain in California due in large part to its Zero-Emission Airport Shuttle Regulation, which mandates that bus operators in 13 of the state's largest airports must fully transition to zero-emission shuttle buses by 2035 (CARB, 2019). However, airports across the nation are accelerating efforts to integrate ZEBs in their fleets. Dallas Fort Worth International Airport has ordered four ZEBs for delivery in 2023. Charlotte Douglas International Airport, the sixth busiest airport in the country, has set a goal to replace its fleet of 60 diesel buses with ZEBs by the end of the decade; 10 ZEBs have already been purchased with an additional five on order.

Table 6: Airport ZEBs State-By-State Distribution (Updated September 2022)

State		Full-Size Buses	Small Buses	Total
California	CA	75	114	189
Florida	FL	4	0	4
Georgia	GA	2	0	2
Hawaii	HI	0	4	4
Indiana	IN	9	2	11
Michigan	MI	2	0	2
Missouri	MO	0	14	14
New Jersey	NJ	12	0	12
New Mexico	NM	0	2	2
New York	NY	24	0	24
North Carolina	NC	14	0	14
Texas	TX	4	6	10
Total	**-**	**151**	**142**	**293**

V. Canadian ZEB Count

Canada continues to see year-over-year growth in ZEB adoptions. As noted in the December 2021 report, the Canadian government has pledged to put 5,000 ZEBs, both transit and school buses, on the road by 2025 as part of the Zero Emission Transit Fund (ZETF). ZETF also includes $10 million to support planning efforts toward fleet electrification (Government of Canada, 2021). Transit agencies in Montréal and British Columbia have committed to having completely zero-emission fleets by 2040. ZEBs are now located in seven of the 10 Canadian provinces, stretching from British Columbia to Québec and Nova Scotia (see **Table 7**).

As of September 2022, Canada has adopted 859 full-size and small ZEBs, including 219 new full-size ZEBs since 2021. Of this total, 849 are BEBs and 10 are FCEBs. The data collected on the Canadian transit market was obtained by analyzing media reports and press releases. CALSTART also confirmed these figures with the Canadian Urban Transit Research & Innovation Consortium's (CUTRIC's) ZEB Database™.

Table 7: Transit ZEBs by Canadian Province (Updated September 2022)

Province	BEBs	FCEBs	Total ZEBs
Alberta	61	0	61
British Columbia	29	0	29
Manitoba	104	0	104
New Brunswick	0	0	0
Newfoundland and Labrador	0	0	0
Nova Scotia	60	0	60
Ontario[2]	519	10	529
Prince Edward Island	0	0	0

[2] FCEBs announced as of the release of this report.

Province	BEBs	FCEBs	Total ZEBs
Québec	74	0	74
Saskatchewan	2	0	2
Total	**849**	**10**	**859**

Ontario, Canada's most populous province, continues to lead the country in adoption with a total of 529 ZEBs, which is five times higher than the next highest province, Manitoba, with 104 ZEBs. The adoption of ZEBs grew overall by 34% from 2021 to 2022, showing continued progress as Canada moves to achieve its net-zero emissions goal by 2050.

VI. U.S. Policy and Funding Sources

The U.S. government aims to transition to ZEBs to combat climate change and improve air quality. Both federal and state governments have introduced policies and funding sources to encourage this transition. These policies and funding sources have been instrumental in accelerating the adoption of ZEBs across the country. In further demonstrating U.S. commitment to zero-emission fleet goals, President Biden signed the **Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles (Global MOU)** in November of 2022**.** This international agreement supports a path to 100% new zero-emission medium- and heavy-duty vehicle (MHDV) sales by 2040 with a goal of 30% new zero-emission MHDV sales by 2030.[3]

The FTA's **Low-No Program** continues to be the main source of federal funding for ZEBs in the United States. The Low-No Program supports U.S. transit fleets as they continue their transition to the most energy efficient and lowest polluting transit vehicles available. Low-No saw a significant boost in funding—$1.10 billion in 2022 compared to $182 million in 2021—due to the passage of the **IIJA,** which was signed into law by President Biden in November of 2021 (FTA, 2022). The IIJA provides $5.25 billion in funding over five years to the FTA's Low-No Program. Low-No is a competitive grant program that helps state and local government entities purchase or lease zero-emission and low-emission transit buses and pay for necessary supporting facilities and infrastructure as well as workforce training for maintenance staff and bus drivers. The Low-No Program has been a major catalyst for ZEB adoption and since its inception has funded more than 2,600 ZEBs. 2022 saw significant demand for Low-No funds with 530 applications submitted and 150 of those applications awarded funding. While not all applications submitted were for zero-emission vehicles or infrastructure associated with zero-emission vehicles, the fact that less than 30% of applications received funding highlights the significant unmet need for funding to support the transition to zero-emission fleets.

[3] The Global MOU is co-led by the nation of the Netherlands and CALSTART's Global Commercial Vehicle Drive to Zero program and campaign; for more information, visit https://globaldrivetozero.org/mou/.

Other federal programs like the **FTA Bus and Bus Facilities Grant Program** and the **Congestion Mitigation and Air Quality Improvement (CMAQ) Program** have also been used to fund ZEB purchases. The IIJA provides $13.2 billion in funding for CMAQ over five years, which will open additional funding sources for ZEB investments. Projects under the FTA Bus and Bus Facilities Grant Program were awarded $551 million in fiscal year 2022 (FTA, 2022).

Newly adopted state-level policies continue to require public transit agencies to transition to zero-emission fleets, and state-level funding for ZEBs to support these requirements has been introduced. California was an early proponent of this technology: **HVIP**, launched by CARB in 2009 and administered by CALSTART, underwrites point-of-purchase price reductions to fleets for clean commercial vehicles on a first-come, first-served basis. HVIP has been a major source of funding for ZEBs. To date, HVIP has administered 637 vouchers for BEBs and five vouchers for FCEBs, accounting for more than $77 million toward point-of-purchase price reductions (CARB, 2022a).

California also enacted the **ICT regulation** in 2018. This regulation requires all public transit agencies to gradually transition their bus fleets to zero-emission technologies. The regulation applies to all transit agencies that own, operate, or lease buses with a gross vehicle weight rating greater than 14,000 pounds, which covers all standard, articulated, over-the-road, double-decker, and cutaway buses. The regulation requires a percentage of new bus purchases to be zero-emission beginning in 2023—by 2029, 100% of all new bus purchases in California must be zero-emission (CARB, 2019a). The goal of the ICT regulation is for all transit agency fleets to be zero-emission by 2040. Three transit agencies have already completed the transition to zero-emission fleets: Antelope Valley Transit Authority, City of Artesia, and the City of South Pasadena. Five California transit agencies are on track to reach zero-emission goals 10 years ahead of schedule: Los Angeles Department of Transportation, Los Angeles County Metropolitan Transportation Authority, Foothill Transit, Long Beach Transit, and Santa Monica's Big Blue Bus.

In addition to California, several other states have implemented programs and policies to support zero-emission vehicle adoption. **NYTVIP**, administered by the New York State Energy Research and Development Authority (NYSERDA), provides vouchers for fleets in New York to replace diesel commercial vehicles with battery-electric, fuel cell electric, plug-in hybrid electric, conventional hybrid electric, compressed natural gas, or propane MHDVs (NYSERDA, 2022).

The **Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding (Multi-State MOU)** was signed in July 2020 by Washington, D.C. and 18 states (California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, Nevada, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington). This effort intends to provide funding sources and incentives for the transportation industry to transition to zero-emission fleets (Multi-State MOU, 2020).

Barriers to the adoption of small ZEBs continue to fall. Statewide procurement contracts are becoming more commonplace. These contracts allow transit agencies to purchase buses from manufacturers at a fixed price without having to issue a request for proposal or initiate the standard procurement process. These contracts speed up the purchasing of small buses and continue to accelerate market growth. In addition to California, states such as Michigan have also implemented statewide procurement contracts. Michigan released the first federally compliant statewide procurement for battery-electric cutaways and transit vans, which may yield the purchase of more than 300 small ZEBs (Metro, 2022). More options for procurement will arrive as an increased number of small ZEBs pass the **FTA Bus Testing Program (Altoona Test)**.

VII. Canadian Policy and Funding Sources

Government policy has driven the rapid growth of ZEBs in Canada. The Canadian government has made combating climate change a policy priority and recognizes that decarbonizing the transportation sector is vital to meeting its climate change goals. Canada aims to decarbonize all transportation sectors, but public transit was identified as a key market segment for decarbonization. The Canadian government views the decarbonization of public transit as an important part of its climate change and economic development strategy. Canada is home to several ZEB manufacturers and seeks to promote zero-emission public transportation as a part of its economic development strategy. In addition, Canada recognizes that adopting these vehicles is instrumental to reduce greenhouse gas emissions. As a result, Canada has enacted multiple policies to encourage the adoption of ZEBs.

The Canadian government began supporting ZEB adoptions in the mid-2010s. Started by Natural Resources Canada, the **Electric Vehicle Infrastructure Demonstration (EVID)** Program received $76 million in funding from the Canadian government under 2016 and 2017 budgets (Government of Canada, 2022). EVID supports demonstrations of next-generation and innovative electric vehicle charging and hydrogen refueling infrastructure. To date, EVID has funded more than 20 demonstration projects, including bus and infrastructure projects at the Toronto Transit Commission, Brampton Transit, and TransLink.

The Canadian government also identified ZEBs as a key area for combating climate change. Canada's **2020 Climate Change Plan** (titled "A Healthy Environment and a Healthy Economy: Canada's Strengthened Climate Plan to Create Jobs and Support People, Communities, and the Planet") aims for the country to be net zero-emission by 2050. This plan includes the electrification of public transit and calls for 5,000 ZEBs (both transit and school buses) (Government of Canada, 2021a).[4] In 2022, Canada announced an inventive program to further spur the adoption of MHDVs. The **Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles** provides $547.5 million over four years toward the purchase or lease of eligible MHDVs (Government of Canada, 2022a).

[4] It should be noted that the Canadian government has not been transparent regarding if buses using renewable natural gas count as ZEBs under their definition.

As previously indicated, the Canadian government provided financing mechanisms to support the 2020 Climate Change Plan's objective of deploying 5,000 ZEBs, most notably through **ZETF.** Funded at $2.75 billion, ZETF was created to support public transit and school bus operators who are transitioning to zero-emission fleets (Government of Canada, 2021). Funding from ZETF can also be used for infrastructure and site upgrades.

In addition, the **Canadian Infrastructure Bank (CIB)** started a program to support the deployment of ZEBs. CIB is a federal Crown Corporation of Canada that works with government and private investors to attract private capital to infrastructure projects, including investing in public transit. CIB currently has a $1.5 billion initiative (in addition to the $14.9 billion from Infrastructure Canada) to deploy 4,000 ZEBs (both transit and school buses) over three years (CIB, 2021).

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Appendix A: Breakdown of ZEB Distribution by FTA Region

The following tables list the count of full-size transit ZEBs for each FTA region by state as of September 2022.

Table A-1: FTA Region 1 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 259 (99% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Connecticut	CT	30	0	30
Maine	ME	6	0	6
Massachusetts	MA	138	3	141
New Hampshire	NH	5	0	5
Rhode Island	RI	63	0	63
Vermont	VT	14	0	14
Total		**256**	**3**	**259**

Table A-2: FTA Region 2 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 531 (127% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
New Jersey	NJ	42	0	42
New York	NY	484	5	489
Total		**526**	**5**	**531**

Table A-3: FTA Region 3 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 286 (44% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Delaware	DE	28	2	30
District of Columbia	DC	48	0	48
Maryland	MD	106	13	119
Pennsylvania	PA	53	0	53
Virginia	VA	36	0	36
West Virginia	WV	0	0	0
Total		**271**	**15**	**286**

Table A-4: FTA Region 4 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 861 (85% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Alabama	AL	20	1	21
Florida	FL	450	0	450
Georgia	GA	107	0	107
Kentucky	KY	40	0	40
Mississippi	MS	1	0	1
North Carolina	NC	121	0	121
South Carolina	SC	42	0	42
Tennessee	TN	79	0	79
Total		**860**	**1**	**861**

Table A-5: FTA Region 5 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 420 (51% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Illinois	IL	135	2	137
Indiana	IN	101	0	101
Michigan	MI	24	4	28
Minnesota	MN	31	0	31
Ohio	OH	50	13	63
Wisconsin	WI	60	0	60
Total		**401**	**19**	**420**

Table A-6: FTA Region 6 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 371 (129% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Arkansas	AR	5	0	5
Louisiana	LA	39	0	39
New Mexico	NM	44	0	44
Oklahoma	OK	12	0	12
Texas	TX	266	5	271
Total		**366**	**5**	**371**

Table A-7: FTA Region 7 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 96 (7% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Iowa	IA	21	0	21
Kansas	KS	19	0	19
Missouri	MO	40	0	40
Nebraska	NE	16	0	16
Total		**96**	**0**	**96**

Table A-8: FTA Region 8 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 239 (21% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Colorado	CO	141	0	141
Montana	MT	18	0	18
North Dakota	ND	0	0	0
South Dakota	SD	0	0	0
Utah	UT	54	0	54
Wyoming	WY	26	0	26
Total		**239**	**0**	**239**

Table A-9: FTA Region 9 (Without California) State-By-State Full-Size Transit ZEB Distribution

Total Buses = 153 (43% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Arizona	AZ	26	12	38
Hawaii	HI	52	7	59
Nevada	NV	41	6	47
Guam	GU	10	0	10
Total		**129**	**25**	**154**

Table A-10: California (FTA Region 9) Full-Size Transit ZEB Distribution

Total Buses = 1,977 (44% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
California	CA	1,841	136	1,977

Table A-11: FTA Region 10 State-By-State Full-Size Transit ZEB Distribution

Total Buses = 286 (0% Growth from 2021)

State		BEBs	FCEBs	Total ZEBs
Alaska	AK	5	0	5
Idaho	ID	37	0	37
Oregon	OR	65	0	65
Washington	WA	177	2	179
Total		**284**	**2**	**286**