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PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

The State of Public Funding and Utility Programs for Medium- and Heavy-Duty Vehicle Electrification

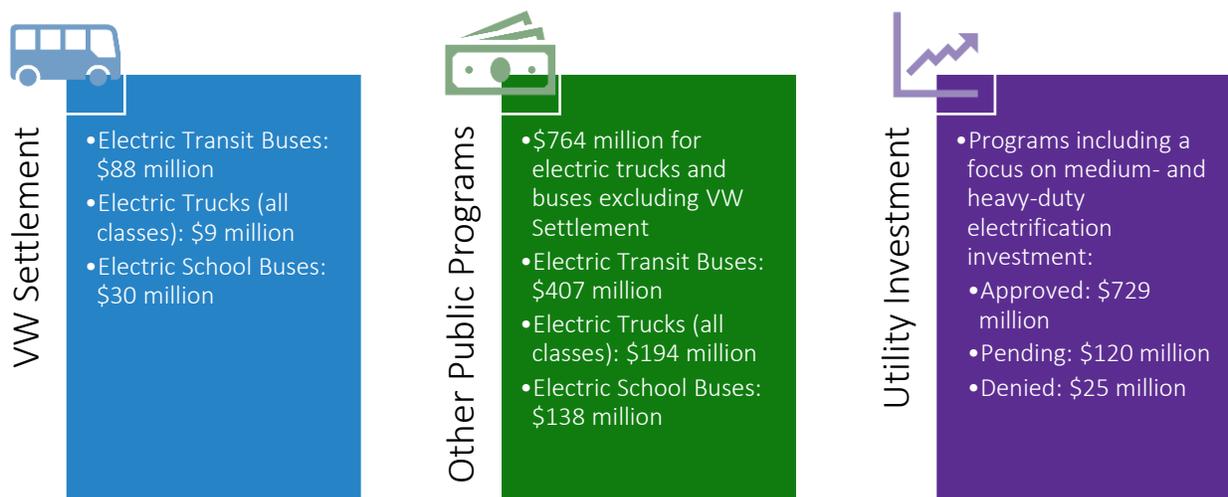
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America’s medium- and heavy-duty vehicles are going electric in response to technological improvements, regulatory requirements, and complementary policies. Manufacturers, transit agencies, and fleet operators alike benefit from a wide range of supportive public programs and investment from electric utilities to accelerate deployment. Increasing investment from the private sector has expanded the range of models available and encouraged innovation in the market, but greater public and electric utility investment is still needed to advance commercialization and push new technologies beyond the pilot phase. This is especially true for electric trucks and school buses, which face lower levels of deployment compared to transit buses. Entities that draw on a range of public and utility programs can increase the likelihood of achieving lifetime savings from electric trucks and buses and rapidly increase adoption.



ELECTRIC BUS AND TRUCK FLEETS EXPANDING NATIONWIDE

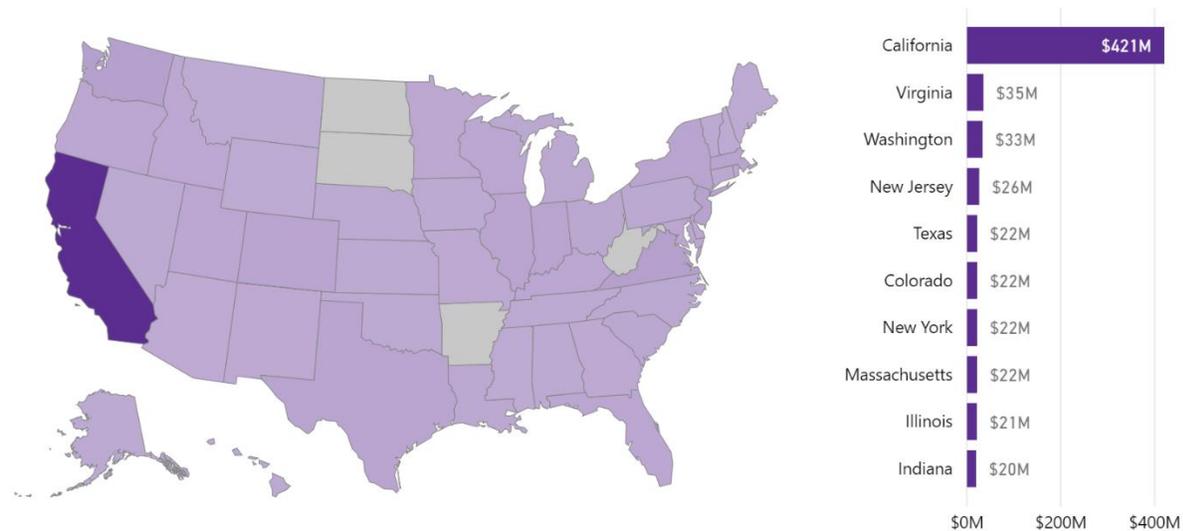
The business case for investing in electric buses and trucks is improving and electric models already have lower lifetime costs than conventional models in some cases [1]. In addition to decreasing battery costs and other technological improvements, increasing public and electric utility funding is helping to reduce high upfront costs associated with electric buses and trucks. Public investments have primarily been driven by state and federal goals to reduce smog-forming pollution, particulate matter, and greenhouse gas emissions from this large sector. While many public investments focus on helping different entities purchase vehicles, electric utility programs are particularly well positioned to expand charging infrastructure access for transit agencies and truck operators looking to electrify fleets. Fleet operators around the country can draw on the VW Settlement, the Federal Transit Administration Low or No

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PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

Emission (Lo-No) Program, and a range of other public programs at the national and state level to reduce the cost of purchasing electric trucks and buses [2]. While the bulk of these programs are directed towards reducing the upfront cost of vehicle purchases, some, including the Low-No program, also include grants for charging infrastructure. Figure 1 shows the concentrations of funding to support the acquisition of medium- and heavy-duty vehicles across the country.

FIGURE 1: PUBLIC FUNDING CONCENTRATIONS FOR ELECTRIC BUS AND TRUCK ACQUISITIONS THROUGH OCTOBER 2019



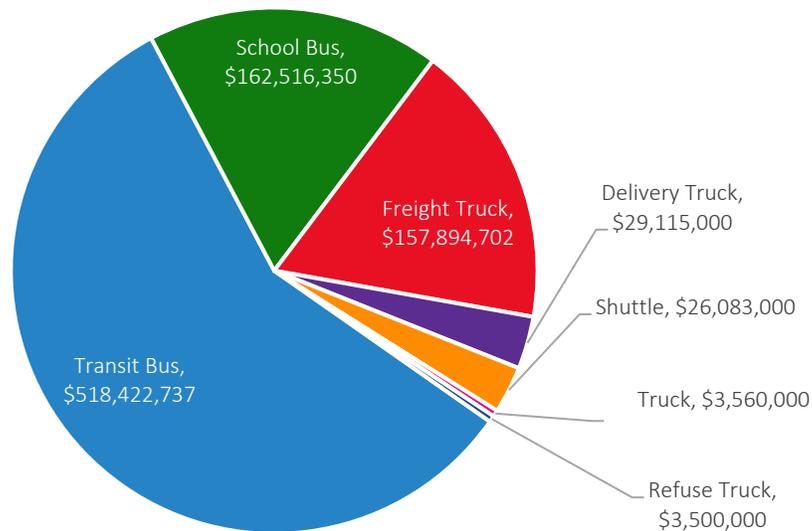
This chart shows the respective amount of public investment in electric buses and trucks throughout the United States through October 2019. Darker colors indicate higher concentrations of funding. 45 states have made public funding awards for medium- and heavy-duty vehicles.

Source: [3]

The Atlas EV Hub is tracking more than \$1.6 billion in public investment in transportation electrification and more than \$890 million has gone towards electric trucks and buses [3]. VW Settlement awards make up \$179 million of all public funding for transportation electrification and roughly half of the settlement awards made through October 2019 will go towards EVs and charging infrastructure. The remaining half of these awards have gone to vehicles powered by diesel, compressed natural gas, propane, and other fuel types. State mitigation plans indicate that medium- and heavy-duty EVs are eligible for up to \$1.77 billion in settlement funds with a majority of the awards yet to be made [4]. Figure 2 shows the relative breakdown of public funding between the three major vehicle categories covered in this report: electric transit buses, school buses, and trucks.

The major vehicle categories all face different levels of commercialization that influence both deployment and public investment [1]. Electric transit buses make up the lion's share of public investment in the sector, accounting for more than \$495 million of the total \$1.6 billion in public funding awards to support the acquisition of electric trucks and buses. Electric school buses have seen a dramatic increase in public funding, rising from only \$22 million at the end of 2018 to more than \$138 million through October 2019. Electric trucks have received slightly more public funding than electric school buses, accounting for \$203 million of the public investment in transportation electrification [3]. A deeper exploration of funding for each of these vehicle categories is provided in subsequent sections of this report.

FIGURE 2: FUNDING BREAKDOWN BY VEHICLE CATEGORY THROUGH OCTOBER 2019



This chart displays the relative proportions of funding for the major vehicle categories and truck subcategories included in this report. Electric transit buses lead, accounting for more than half of all public funding.

Source: [3]

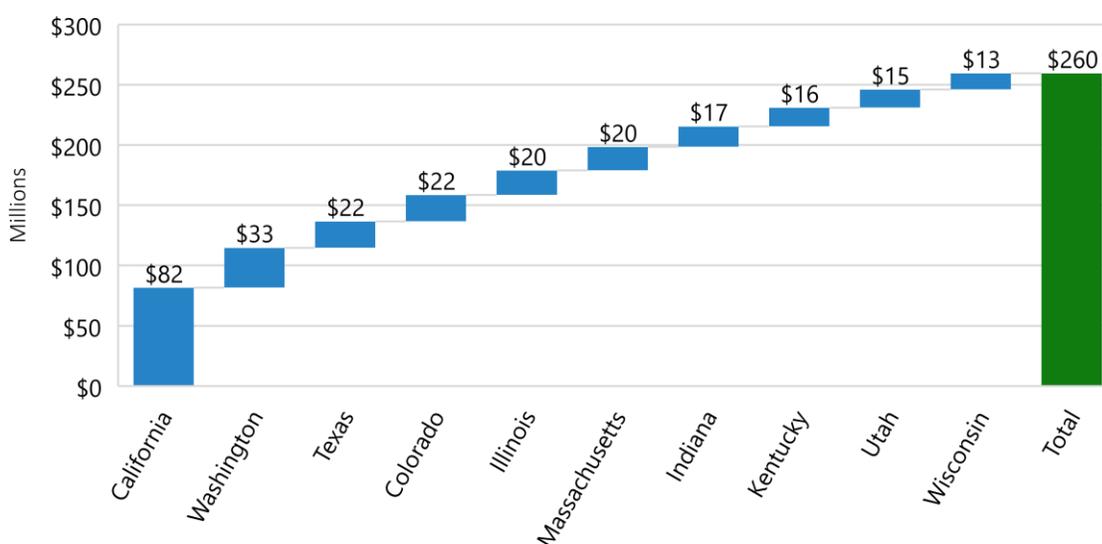
Electric utilities are also increasing their role in the electric bus and truck market, proposing new commercial and industrial rates designed for higher power transportation electrification use cases and investing in charging infrastructure and vehicle rebates. Of these options, utility rate design offers a straightforward way to advance medium- and heavy-duty electrification, often at no additional cost to ratepayers. Only five out of the 33 approved EV rates tracked on the EV Hub Utility Filings Dashboard included a ratepayer cost component [5]. If the rates are designed to reflect the cost of delivering electricity at different times, fleet operators can save money by charging during off-peak times while also delivering grid services through load balancing where demand is spread out more evenly throughout the day [6].

To encourage truck and bus electrification, major California utilities including Pacific Gas and Electric (PGE&E) and Southern California Edison (SCE) have both been approved to offer commercial EV rates that specifically address the more unique charging patterns and costs associated with EVs, rather than subsidizing charging and lumping EVs into more general rate categories. In lieu of potentially high demand charges levied on commercial EV fleets for charging, PG&E is also offering lower cost subscription-based fees to commercial fleets to help eliminate the potential barrier. SCE is offering lower off-peak charging rates specifically for commercial and industrial EVs to reduce fleet operator bills [7]. In addition to time-of-use rates, utilities in eight states have been approved to invest more than \$729 million in programs which include some focus on medium- and heavy-duty electrification. Today, California accounts for almost 99 percent of that approved investment, but pending investment worth more than \$120 million is more widely distributed with nine additional states looking to invest in this sector.

FUNDING ACCELERATES ELECTRIC TRANSIT BUS DEPLOYMENT

More than \$518 million in public funding has been awarded for electric transit buses. The funding is spread out across 46 states and Washington D.C. and a majority of it comes from the federal Low or No Emission (Low-No) Bus Program, accounting for more than 60 percent of all electric transit bus funding tracked on the EV Hub since it began in 2015 [3]. The VW Settlement is the next largest pool of resources available for transit bus electrification. Figure 3 presents the estimates for the top 10 states for electric transit bus investment from the EV Hub, with California and Washington leading the way.

FIGURE 3: TOP 10 STATES FOR PUBLIC TRANSIT BUS FUNDING THROUGH OCTOBER 2019



This chart shows the top 10 states for electric transit bus funding through October 2019. California and Washington stand ahead of the remaining top states.

Source: [3]

The 10 states listed in Table 1 account for more than half of the total public investment in electric transit buses. While electric transit buses still cost roughly twice as much as their diesel counterparts upfront, the total cost of ownership (TCO) for electric transit buses is lower than diesel models in some cases, particularly when public programs are utilized [1]. States that benefit from significant public funding in this technology have been able to accelerate adoption [8]. States with the highest electric transit bus deployment as reported by CALSTART through August 2018 generally align with the states that have received the most public funding through Low-No and other programs [9].

States with the highest funding and deployment levels also benefit from supportive public policies and commitments encouraging rapid transit electrification. For example, New York City and Seattle have committed to full bus fleet electrification before 2040 [10, 11]. Hawaii and California have implemented statewide electric bus commitments as well. Hawaii has set a goal of complete transportation electrification by 2045 and California will stop purchasing diesel transit buses by 2029 [12, 13]. In

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

California, electrification targets are supported by public funding from programs like the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), which offers vouchers for EVs, and the Low Carbon Fuel Standard (LCFS), which requires the carbon intensity of transportation fuels be reduced by at least 20 percent by 2030 from a 2010 baseline [14]. Credits for all low-carbon fuels generated through the LCFS program were valued at \$2 billion in total through 2018. The positive impact these credits have on vehicle TCO is covered further in Atlas’s Electric Bus and Trucks Overview [1].

States are also capitalizing on VW Settlement funding to expand electric transit bus fleets. VW Settlement awards worth more than \$88 million have been distributed to public transit agencies across 15 states since 2018. More than 66 percent of VW Settlement awards for transit buses of all fuel types have gone to electric models and electric transit buses account for 24 percent of the total \$363 million that has been awarded through the VW Settlement through October 2019 [3]. Colorado has invested almost all \$14 million of the state’s VW Settlement awards made so far into electric transit buses. This spending is supported by an executive order from the governor issued in January 2019 ensuring all remaining unallocated VW settlement investment goes towards EV or charging station deployment [15].

TABLE 1: APPROVED ELECTRIC UTILITY FUNDING SUPPORTING ELECTRIC TRANSIT BUSES THROUGH OCTOBER 2019

Utility	State	Vehicle Investment	Charging Investment	Total Investment
Southern California Edison	California	\$46.6 M	\$47.7 M	\$94.3 M
Pacific Gas and Electric	California	\$23.9 M	\$27.3 M	\$51.2
San Diego Gas and Electric	California	\$9.5 M	\$10.8 M	\$20.3 M
Rocky Mountain power	Utah	\$0	\$2 M	\$2 M
Portland General Electric	Oregon	\$0	\$0.8 M	\$0.8 M
PEPCO	D.C.	\$0	\$0.54 M	\$0.54
Liberty Utilities	California	\$0	\$0.22 M	\$0.22 M
Hawaiian Electric	Hawaii	N/A (EV Rate)	N/A	N/A
Consolidated Edison	New York	N/A (EV Rate)	N/A	N/A
Total		\$80 M	\$89.4 M	\$169.4 M

This table outlines specific budget allocations for transit buses within approved electric utility programs with a focus on mass transit electrification through October 2019. To calculate the total investment in transit buses for the California programs, the specific budget for transit buses was added to the rebates available for this vehicle category. Investment totals are subject to change as programs are implemented and the table above does not include all potential investment in this vehicle category.

Source: [5]

Pending investment targeting mass transit is spread across 10 states, none of which include California, and is worth more than \$104 million [5]. Significant pending programs include \$45 million from Public Service Electric and Gas Company in New Jersey and \$21.5 million from New York State Electric and Gas and

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

Rochester Gas and Electric in New York. A \$3.4 million pilot from Duke Energy in North Carolina was the only program seeking mass transit electrification that has been denied so far. The utility has already filed another transportation program which includes a transit bus component worth \$8.2 million [5].

Electric utilities like Hawaiian Electric and Portland General Electric are also piloting transit bus programs that seek enhanced grid integration and greater alignment with regional climate goals. Hawaiian Electric was approved in March 2019 to implement a reduced electricity rate for off-peak transit bus charging. The reduced rate will improve the business case for operating electric transit buses and could lead to increased deployment across the state. The rate also seeks to increase the use of renewable energy resources that are generated during off-peak times [16]. Portland General Electric is partnering with TriMet, the primary Portland-area transit agency, to offer bundled renewable energy credits to ensure the agency's buses run on clean energy and enhance progress towards the regional climate action plan [17].

Private entities are also stepping up their investment in transit bus electrification. While medium- and heavy-duty investment is often included as a component of vehicle manufacturers' general electrification strategies, the EV Hub is tracking more than \$1.2 billion in private investment specifically targeted for electric buses around the world [18]. The American bus manufacturer Proterra accounts for the largest portion of this investment with more than \$535 million committed so far, including \$200 million in financing for their battery leasing program secured in April 2019. The program will allow transit agencies to purchase electric buses from Proterra at or below the price of a diesel bus while leasing the batteries for a 12-year period. This battery lease arrangement converts the higher capital cost of the electric bus to an operating cost which can be covered by fleets through the expected operating savings. Proterra's leasing arrangement guarantees the performance of the battery over the 12-year period or will replace the batteries. Used batteries will be repurposed for second life as stationary energy storage followed by recycling [19].

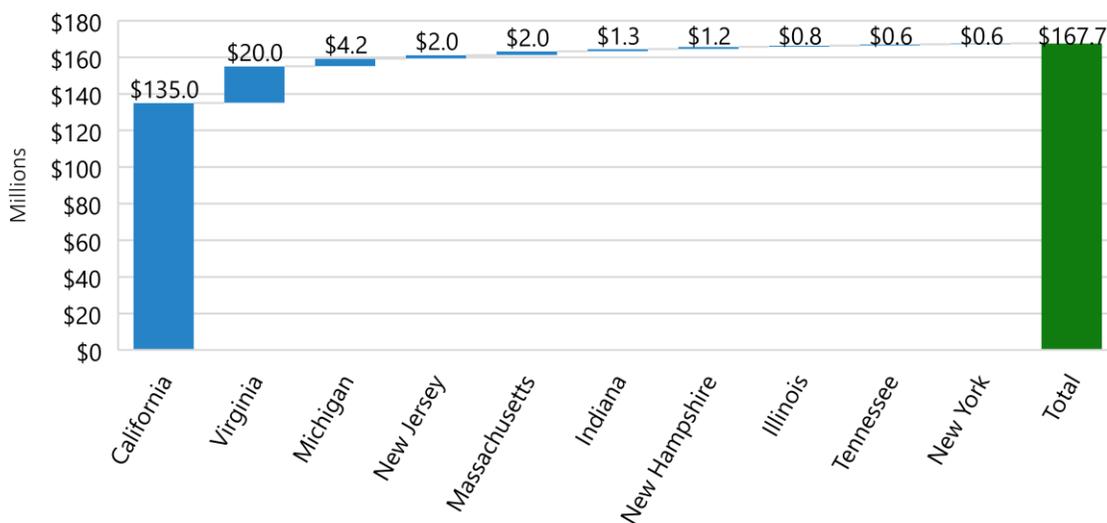
ELECTRIC SCHOOL BUSES GAIN GROUND

Electric school buses lag far behind transit buses in terms of funding, although this category has seen a relative flurry of investment announcements in 2019 as pilot programs are completed and larger deployments ordered. While some states including Massachusetts and New York have run electric school bus pilots [20, 21], California is the only state to invest a significant amount of public funds in this technology and accounts for almost all of the non-VW public funding for this vehicle category. California's investment totals \$135 million for at least 300 buses, most of which comes from a \$90 million program administered by the California Energy Commission [22]. The remaining investment comes through vouchers offered through the state's Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP) [23]. The state has issued \$26 million in vouchers for electric school buses through the HVIP project since it began in 2009 [3].

Through October 2019, electric school buses have only received 23 percent of the total \$130 million invested in school buses across all fuel types through the VW Settlement. Funding for electric school buses increased from only \$4 million to more than \$28 million following the announcement in September 2019 of a \$20 million investment from Virginia and a \$4.2 million pilot program in Michigan [4, 24, 25]. Several states that have not yet made electric school bus awards including Vermont, Illinois, and Minnesota are in the process of developing electric school bus programs that will be funded through the VW Settlement, according to their state mitigation plans [26]. Figure 4 highlights the state-level investment in electric school buses across all programs as tracked on the EV Hub.

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

FIGURE 4: STATE-LEVEL INVESTMENT ANNOUNCEMENTS IN ELECTRIC SCHOOL BUSES THROUGH OCTOBER 2019



This table shows state-level funding in electric school buses. California is far in the lead with Virginia significantly ahead of the rest of the states investing VW Settlement funds in this technology.

Source: [3]

A report from the United States Public Interest Research Group estimates that annual fuel cost and maintenance savings for an electric school bus compared to a diesel model can be as high as \$6,400 per bus [26]. School districts and bus fleet owners depend on fuel cost savings to make the switch to electric models and these lifetime savings are only possible if fleet operators have access reduced rates for off-peak charging [7]. Because of the current level of commercialization, lifetime savings are only possible if public funding is awarded to accelerate the deployment of this technology according to a new report from ICF international [1, 27]. To date, there are no federal programs subsidizing electric school bus purchases and California is the only state to designate considerable public funds outside the VW Settlement to this technology.

Electric utilities have an opportunity to significantly boost the electric school bus market and close funding gaps by capturing the value of the school bus batteries, especially during summer months when many school buses go unused. A significant proportion of utility investment in the school bus sector focuses on pilot projects exploring bi-directional power exchange (V2G) between buses and the grid to improve the value proposition of vehicle-grid integration (VGI). Based on the proposed budgets of several programs, electric utilities have been approved to invest more than \$60 million directly for electric school buses and charging infrastructure [5]. Table 2 summarizes the budgets of each utility program with a school bus focus and estimates the amount of money from these programs that will go directly towards school bus electrification. As is the case with transit buses, school bus funding could increase as utilities implement programs; several approved programs at utilities include a focus on school buses, but do not have specific budget carve-outs and are not included below.

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

TABLE 2: APPROVED ELECTRIC UTILITY FUNDING SUPPORTING ELECTRIC SCHOOL BUSES THROUGH OCTOBER 2019

Utility	State	Vehicle Investment	Charging Investment	Total Investment
Southern California Edison	California	\$18.0 M	\$7.9 M	\$25.9 M
Pacific Gas & Electric	California	\$13.4 M	\$6.6 M	\$20.0 M
San Diego Gas & Electric	California	\$6.6 M	\$4.9 M	\$11.5 M
DTE Energy	Michigan	\$0 M	\$1.9 M	\$1.9 M
Consolidated Edison	New York	\$0 M	\$1.1 M	\$1.1 M
Total		\$38 M	\$22.4 M	\$60.4 M

This table details budget allocations from approved utility programs with a focus on school bus electrification through October 2019. California accounts for almost all approved investment in this category. To calculate the total investment within the California programs, the specific budget for school buses was added to rebates available to school buses through the program. A \$1.7 million V2G pilot was also added to the San Diego Gas & Electric total. Liberty Utilities pilot not included because the budget does not indicate how many charging stations will support school buses.

Source: [5]

California leads the way in exploring school buses as a grid asset, accounting for more than 98 percent of approved utility investment with a focus on school bus electrification. Each of the three major utilities and some smaller ones including Liberty Utilities in the state are tapping electric school buses as a valuable resource for VGI programs and are investing millions into rebates for electric school buses and charging infrastructure [5]. Pending investment targeting school bus electrification could bring in almost \$74 million of additional funding. Outside of California, the \$45 million program from Public Service Electric and Gas in New Jersey mentioned in *Funding Accelerates Electric Transit Bus Deployment* and \$18.5 million from Duke Energy in North Carolina are noteworthy [5].

While not included on the EV Hub because no formal filing has been issued, Dominion Energy is seeking state approval for a new plan to invest in more than 1,000 electric school buses over five years in their Virginia service territory [28]. This would increase the estimated electric school bus deployment across the country by more than five times [1]. Virginia public agencies are working to accelerate the electric school bus market beyond the Dominion service territory. Following the Virginia Governor’s September announcement awarding \$20 million to the technology, the state now accounts for more than 67 percent of all electric school bus funding through the VW Settlement [24]. The opportunity to expand these partnerships is growing, and Michigan is also pursuing both utility and state investment in school buses as valuable resources for VGI programs [29].

Electric school buses also benefit from the \$1.2 billion private companies are investing in buses of all classes globally [18]. Lion electric leads in terms of bus deployment throughout the United States, but has not publicly disclosed their investment figures. Other electric school bus manufacturers including Blue Bird are working with Cummins to capitalize on the company’s \$500 million global investment in electric bus powertrains [30]. In September 2018, transit bus manufacturer Proterra finalized a \$155 million deal with Daimler’s Thomas Built Buses to collaborate on drivetrain development for electric school buses [31].

ELECTRIC TRUCKS BEGIN TO MOVE PAST PILOT PHASE

Although electric trucks have been slow to move beyond the pilot phase and into commercialization, public funding is increasing and the business case for electrifying truck fleets is improving [27]. Freight, delivery, and refuse trucks, which account for almost all of the on-road trucks tracked on the EV Hub, have received a combined \$203 million in public funding.¹ California claims \$179 million of this investment through the California Climate Investments (CCI), funded by the state’s cap-and-trade and HVIP programs [3, 23]. New York is also investing in vouchers for electric trucks and has allocated at least \$9 million to this technology through their Voucher Incentive Program (NYT-VIP) [32]. Idaho, New Jersey, and Indiana are the only states that have made VW Settlement awards for electric trucks so far worth a combined \$8.6 million. Off-road vehicles, including airport ground support equipment and port vehicles have received \$174 million in funding but are out of scope for this brief. Table 3 shows the breakdown of funding based on truck classification through October 2019.

TABLE 3: INVESTMENT BY VEHICLE TYPE THROUGH OCTOBER 2019

Vehicle Type	Classes	Funding
Freight Truck	7,8	\$158 M
Delivery Truck	4-7	\$32.7 M
Refuse Truck	7	\$9.2 M
Other Trucks	4-7	\$3.6 M
Total		\$203 M

This table shows the breakdown of funding by different truck categories that are recorded on the EV Hub. Freight trucks are far in the lead in terms of total public investment. Class categorizations were left as general as possible to capture all funding and facilitate data collection.

Source: [3]

The ICF estimates that the average electric truck costs twice as much as a conventional fuel alternative [8]. As is the case with electric school buses, electric trucks have faced low commercialization and have been mostly deployed as pilot technologies in several initiatives managed by both public agencies and private companies so far. Key public initiatives and pilot projects have helped to jump start the market in states like California, which again leads the way in terms of public investment in electric trucks. The state is working directly with manufacturers through the CCI program and supporting private fleet electrification with vouchers through the HVIP. Table 4 provides an overview of the HVIP spending through October 2019 [23].

The HVIP program is not the only source of funding for heavy-duty trucks and overall, at least 40 electric drayage trucks are being tested in California, drawing on funding sources including the CCI program [8].

¹ In this paper, “freight trucks” are both class 7 and class 8 trucks weighting more than 26,000 lbs. “Delivery Trucks” include all medium trucks from Classes 4 through 6 with a weight between 14,000 and 26,000 lbs.

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

This investment has spawned partnerships between regional air quality management agencies and manufacturers like Volvo seeking to develop and introduce new electric trucks to the market in 2020 [33].

TABLE 4: CALIFORNIA HVIP SPENDING BY VEHICLE TYPE THROUGH OCTOBER 2019

Vehicle Type	Total Vouchers	Funding
Freight Truck	271	\$30.2 M
Delivery Truck	242	\$13.1 M
Refuse Truck	4	\$500 k
Total	517	\$44 M

This table provides a breakdown of the number of vouchers issued and investment amounts for different vehicle categories through October 2019. Delivery trucks includes beverage delivery, parcel delivery, and all “other” trucks weighing between 14,000 and 26,000 lbs. Freight trucks are assumed to be all “other” trucks weighing more than 26,000 lbs.

Source: [23]

Electric utility investment in electric trucks and especially in charging infrastructure exceeds public funding for this technology. Across all classes of trucks, electric utilities in three states have been approved to invest more than \$220 million in truck electrification [5]. The estimates provided in Table 5 include all potential investment targeting electric truck charging including general categories that could cover vehicles other than delivery, freight, or refuse trucks. A \$2 million program by Rocky Mountain Power in Utah was left out of the table as the specific allocation for truck charging was not specified and funding is assumed to go to transit buses first. As is the case with the other vehicle categories, truck investment could change as programs are implemented.

California utilities account for almost all the approved utility funding for electric trucks in the United States. Pending programs on record would add \$45 million to the total investment, nearly all of which is accounted for by the Public Service Electric and Gas filing in New Jersey that includes transit and school bus investments. Three programs worth more than \$5 million targeting truck electrification have been denied [5].

While their program does not include any direct investment, Consolidated Edison in New York was approved in 2018 to offer reduced rates for off-peak charging specifically targeting electric trucks and buses. The program seeks to improve the business case for truck fleet electrification and can encourage fleet operators to invest in electric models with the prospect of significant fuel cost savings. These fuel cost savings are enhanced by new EV rates and the reduction of high demand charges for truck charging [34]. Con Ed’s program interfaces with public programs like the Voucher Incentive Fund administered by the New York State Energy and Research Development Authority (NYSERDA). All-electric trucks are eligible for nearly \$9 million in vouchers through the program and funding is expected to increase with infusions from the VW Settlement [32].

On a regional level, western utilities are exploring projects that would create a corridor of electric truck charging along Interstate 5. All three major California utilities, Puget Sound Energy, and Portland General Electric are among the nine regional and 24 municipal utilities participating in the study that would deploy fast charging for freight trucks along the entire 1,350 mile stretch [35].

TABLE 5: APPROVED ELECTRIC UTILITY INVESTMENT SUPPORTING ELECTRIC TRUCK CHARGING THROUGH OCTOBER 2019

Utility	State	Port Truck Charging Investment	MD Vehicle Charging Investment	HD Vehicle Charging Investment	Total Investment
Southern California Edison	California	\$4.0 M	\$59.2 M	\$35.8 M	\$99.1 M
Pacific Gas and Electric	California	\$2.0 M	\$59.2 M	\$20.5 M	\$81.7 M
San Diego Gas and Electric	California	\$1 M	\$28.4 M	\$9.8 M	\$39.2 M
Consolidated Edison	New York	N/A (EV Rate)	N/A	N/A	N/A
Total		\$7 M	\$146.8	\$66.1 M	\$220 M

This table outlines all approved electric utility programs with a focus on truck electrification through October 2019. For the California utilities, total investment was taken by adding specific budget allocations for port trucks, medium- and heavy-duty vehicles, and all other heavy-duty vehicles. A \$2 million Rocky Mountain Power project was left out as investment is assumed to go to transit buses first.

Source: [5]

With industry leaders like Daimler and Tesla announcing their transportation electrification strategies, there has been significant private investment in electric trucks over the last two years. The EV Hub has documented more than \$8 billion in private investment specifically for electric trucks, not including Tesla since they have not released truck-specific funding figures [18]. Daimler leads in terms of investment in electric trucks with more than \$3.2 billion in specific truck projects announced. Amazon announced that it would order 100,000 electric delivery vans from Rivian in September 2019, the largest order of this class of EVs to date [36]. This order follows a \$700 million investment in Rivian by Amazon announced in February 2019 [37]. Freight trucks have also benefitted from increasing private investment with companies like Nikola reporting more than \$1 billion in investment for both electric and hydrogen freight truck development [18].

ELECTRIC BUS AND TRUCK DEPLOYMENT SET TO INCREASE

EV market forecasts predict growth in both the light-duty, medium-, and heavy-duty sectors over the next several decades [38]. Bloomberg New Energy Finance's EV Outlook for 2019 forecasts that electric transit buses will make up 81 percent of new bus sales by 2040, but predicts a slower adoption rate for electric trucks. The forecast calls for medium-duty trucks to account for 31 percent of new vehicle sales while heavy-duty trucks will account for only 19 percent by 2040 [39]. Continued declines in battery costs and technological advancements in the EV manufacturing space are expected to spur this market growth in the long run [8, 39].

Public investment in the sector will likely remain important in the near term to improve the value proposition for electric trucks and buses compared to conventional and other alternative fuel vehicles.

PUBLIC AND ELECTRIC UTILITY SUPPORT FOR ELECTRIC BUSES AND TRUCKS

This is especially true for electric school buses and trucks that have not yet reached full commercialization.

Electric utility rate redesign is essential and direct investments in vehicles and infrastructure are key resources for the growing medium- and heavy-duty electrification market, although increased investment outside of California is needed to ensure the technology is adopted nationwide. Emerging technologies and separate EV rate schedules that improve the value proposition of electric trucks and buses, such as V2G for school buses will likely play a role in market acceleration. California is already working to bring together different public agencies and electric utilities to expand these efforts across the state through the VGI Working Group [40]. Policymakers and electric utilities in other states can look to work of the VGI Working Group as a promising way to identify the role of public policy and the electricity utility to advance electric trucks and buses across the United States.

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