ELECTRIC TRUCKS AND BUSES OVERVIEW

The State of Electrification in the Medium- and Heavy-Duty Vehicle Industry

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Electrification in the medium- and heavy-duty vehicle sector is increasing in the United States with California leading the way. Low commercialization for all vehicle categories other than transit buses and high upfront costs have limited deployment so far. Increasing investment in the sector from public and private sources, however, is expected to generate growth and significantly increase the number of electric trucks and buses on the road in the near term. Upfront costs associated with electric trucks and buses are expected to decline significantly through 2030 as battery prices fall, making them competitive on a total cost of ownership (TCO) basis.

Deployment

- Electric Transit Buses: 1,650
- Electric Trucks (all classes): 300
- Electric School Buses: 150

Investment

- $590 million in public funding for electric buses (43 states) and trucks (10 states)

Price Parity Estimates

- Electric Transit Buses: 2019-2020
- Electric School Buses: 2025-2030
- Electric Trucks: 2025

OVERVIEW

Electrification in the medium-and heavy-duty sector is on the rise in the United States. Globally the market for electric trucks is expected to grow by 20 percent in 2019 [1]. Bloomberg estimates that 80 percent of the global transit bus fleet will be electric by 2040 [2]. While transit buses are fully available at the commercial level, electric shuttles, school buses, delivery trucks, refuse trucks, tractors, and drayage trucks are in the early stages of commercialization. Electric freight trucks have not yet reached commercial availability.

The electric bus and truck industries continue to benefit from increased public funding through the VW Settlement and investment from leading manufacturers continues to expand deployment. California leads the nation in deployment of EVs and programs such as the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), which have accelerated the deployment of zero emissions trucks and buses. Through the program, 660 vouchers for as many ZEVs have been offered with concentrations in the Bay Area and Los Angeles County [3]. New York offers a similar program through their Truck Voucher

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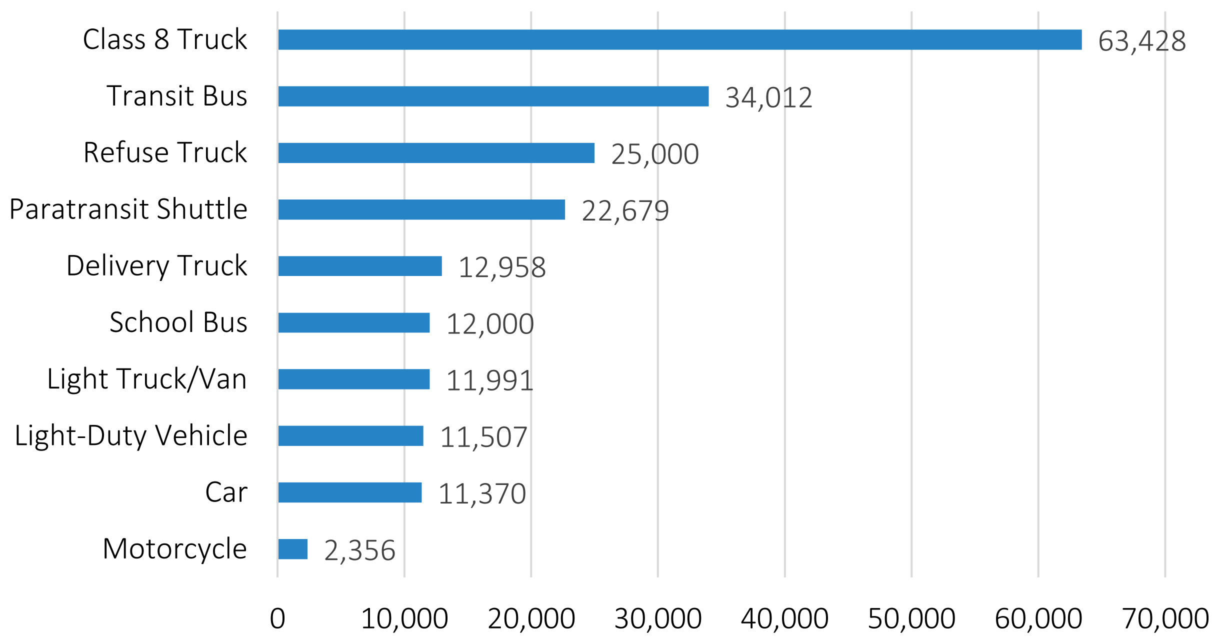
Incentive Program and has set aside substantial VW funding for medium- and heavy-duty electrification [4]. In California, the HVIP program is supplemented by the California Low Carbon Fuel Standard (LCFS) Program and seeks a 20 percent reduction in the carbon intensity of the transport sector by 2030. This credit market provides another resource for fleet owners to reduce the cost of electrification and was valued at $2 billion in 2018 [5].

FIGURE 1: AVERAGE ANNUAL VEHICLE MILES TRAVELED OF MAJOR VEHICLE CATEGORIES IN 2018



This chart compares vehicle miles traveled by categories of medium- and heavy-duty vehicles with Class 8 far outpacing other categories.

Source: [6]

The average annual vehicle miles travelled (VMT) by different categories of medium- and heavy-duty vehicles varies significantly. Across all categories of medium- and heavy-duty vehicles, Class 8 trucks far outpace other types of vehicles in terms of average vehicle miles travelled (VMT).

Transit buses follow Class 8 trucks, with an average VMT more than three times higher than school buses and medium trucks. High VMT and emissions have helped to accelerate public pressure on transit bus electrification and that market has grown faster than other medium- and heavy-duty categories.

Transit buses lead in terms of deployment, with 43 states investing in electric buses. By comparison, less than 10 states have invested public funds into medium- and heavy-duty ZEVs excluding buses [7]. California is considering regulations that would require five percent of the state's roughly 1.5 million trucks to be zero emission by 2030 [8]. At the end of 2018, the state passed regulations requiring that all new transit buses purchased be zero emission by model year 2029 [9].

TRANSIT BUSES

Bloomberg New Energy Finance estimates that there were 360 electric buses in the United States at the end of 2017 [2]. The market has been growing quickly, and CALSTART estimates that zero emission transit buses will increase from one percent of the national fleet to 20 percent by 2030 [10]. Under the current California grid mix, electric transit buses offer lifetime emissions reduction potential of up to 74 percent [11]. Their report from February 2019 estimates that there are 1,650 electric and fuel cell buses in operation or on order across the country. Table 1 presents the estimates for the top states for zero emission transit bus deployment from the CALSTART report, with California and Washington leading the way.

TABLE 1: TOP STATES FOR ZERO EMISSION TRANSIT BUS DEPLOYMENT THROUGH AUGUST 2018

State	Number of Buses
California	877
Washington	154
Florida	70
Indiana	66
Illinois	61
Colorado	44
New York	29
Pennsylvania	27
Texas	24
South Carolina	22
Georgia	21
Kentucky	21
Total	1,416

This table highlights the top 10 states for zero emissions bus deployment according to CALSTART's 2018 report. California is the national leader by a significant margin.

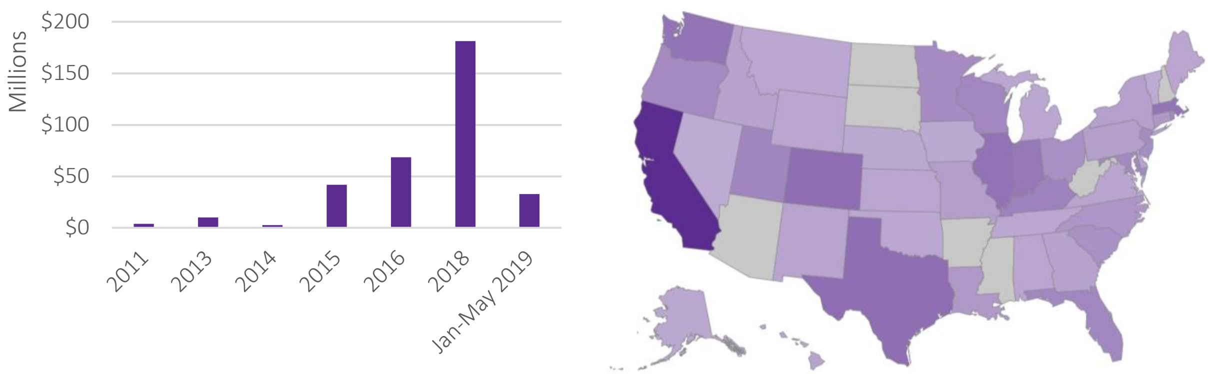
Source: [10]

The distribution of public funding for electric buses throughout the country generally supports these deployment estimates. Figure 2 shows that the states with the highest amount of public funding allocated, marked with darker shades, are also included in CALSTART's top 10 list.

According to the EV Hub, 43 states have received public funding to purchase electric transit buses [12]. Upfront costs of electric buses have come down from almost $1,200,000 in early commercialization periods to roughly $750,000 today [11]. Despite progress, electric buses are still roughly twice as expensive as diesel alternatives (see Table 2). Financing mechanisms like Proterra's battery leasing program, which allows customers to purchase the vehicle while leasing the battery from Proterra, could make electric buses even more accessible by lowering vehicle upfront costs [13]. Table 2 provides a summary of the price and technical differences between different transit bus models.

Electric transit buses have achieved a lower total cost of ownership (TCO) than diesel and CNG-fueled buses in some cases, although the likelihood of achieving savings remains uncertain. TCO is expected to improve as upfront vehicle costs decline further. The 2018 ICF report, Medium- and Heavy-Duty Electrification in California, presents a range of lifetime cost calculations with lower TCO for electric buses in some cases and higher TCO in others. The report cites a study from the Los Angeles County MTA had a lifetime cost of $4.27 per mile for electric buses compared to $4.18 per mile for CNG buses. The National Renewable Energy Laboratory (NREL) reports a higher levelized cost for electric buses of $4.43 per mile compared to $3.93 per mile for diesel buses [11].

FIGURE 2: FUNDING AWARDS FOR ELECTRIC TRANSIT BUSES AS OF MAY 2019



This chart shows the total amount of public funding for electric transit buses from 2011 through 2019 in the U.S., demonstrating higher concentrations of buses in darker shades that generally support the CALSTART data.

Source: [14]

TABLE 2: TRANSIT BUS MODEL COMPARISON

Manufacturer	Model	Fuel Source	Purchase Cost	Range (mi.)
BYD	K9S	Battery Electric	$770,000	230
Gillig	BRT Electric	Battery Electric	$1,000,000	200
New Flyer	Xcelsior CHARGE	Battery Electric	$800,000	230-260
Proterra	Catalyst E2	Battery Electric	$750,000	169-276
El Dorado	Axess	CNG	$490,000	NA
Gillig	BRT CNG	CNG	$430,000	NA
New Flyer	Xcelsior CNG	CNG	$458,000	NA
El Dorado	Arrivo	Diesel	$400,000	NA
Gillig	BRT Diesel	Diesel	$380,000	NA

Manufacturer	Model	Fuel Source	Purchase Cost	Range (mi.)
New Flyer	Xcelsior Diesel	Diesel	$420,000	NA
El Dorado	Axess FC	Fuel Cell	$1,200,000	200-300
New Flyer	Xcelsior CHARGE H2	Fuel Cell	$850,000	260-300
El Dorado	Axess Hybrid	Hybrid Electric	$630,000	NA
Gillig	BRT Hybrid	Hybrid Electric	$635,000	NA
New Flyer	Xcelsior Hybrid	Hybrid Electric	$650,000	NA

This table provides estimates for the upfront costs of different transit bus models including several fuel types. Electric and fuel cell buses have a higher purchase price than other fuel types.

Sources: Manufacturer websites are linked above in the table. Cost assumes 35 ft bus [15]

Manufacturers such as Proterra self-report lifetime cost savings as high as $433,000 associated with their technology [16]. These savings are slightly higher than estimates made by the California Air Resources Board, calculating that electric transit buses could generate lifetime savings of up to $400,000 compared to diesel buses and $200,000 compared to CNG buses by 2020 [11]. Public programs such as the Federal Low-No Emissions program can bring the upfront costs of electric transit buses down, improving the business case. The Low-No program has already allocated more than $230 million to electric transit buses since 2015.

Grant programs make a significant difference according to forthcoming report by ICF. This analysis included grants from HVIP, LCFS, and electric utility programs. Current California transit buses with public subsidies of approximately $250,000 per vehicle are estimated to have an average TCO roughly $140,000 lower than diesel alternatives. This will improve over time, where electric transit bus TCO is expected to be $240,000 lower than diesel alternatives by 2030 without public subsidies but with the LCFS remaining in place [17].

SCHOOL BUSES

According to the Vermont Energy investment Corporation (VEIC), less than 50 school buses out of more than 400,000 nationwide were electric as of May 2018 [18]. School buses outnumber transit buses roughly five to one [11]. Throughout 2018, school districts across California took the lead and deployed 150 buses with support from public agencies [19]. Electric utilities are emerging as a key partner for electric school bus adoption and several pilot projects are operating throughout the county. Several states including Vermont, New York, Illinois, Minnesota, and Massachusetts are developing electric school bus pilot programs through the VW Settlement [20].

In October 2018, leading transit bus manufacturer Proterra announced a partnership with Daimler's Thomas Built Buses [21]. The companies will team up to produce electric buses using Thomas' models and Proterra's powertrain. Production is ongoing and the first of these buses are expected by the end of 2019. Table 3 shows the significant gap in upfront costs between electric and conventional school bus models.

Due to lower annual mileage compared with transit buses, the TCO of an electric school bus compared to a diesel alternative is less favorable. However, reduced exposure of children to harmful pollutants is a key benefit of this technology [20]. The U.S. Public Interest Research Group estimates an average lifetime fuel and maintenance savings of between $170,000 and $240,000 for each electric school bus compared to diesel alternatives [20]. Electric school buses cost roughly three times as much as conventional fuel models at the current level of market development, outweighing the operating cost savings potential in most cases. Technological advancements and market growth are expected to bring down upfront costs and improve the TCO of electric school buses. Annual savings across the country could exceed $2.9 billion if the entire national school bus fleet was converted from diesel to electric [22].

According to the forthcoming study from ICF mentioned above, current California Class C electric school buses with a public subsidy of approximately $175,000 per vehicle have a TCO $14,000 lower than diesel buses. Without only the LCFS remaining in 2030, an electric school bus TCO is expected to be $115,000 higher than diesel alternatives [17].

TABLE 3: SCHOOL BUS MODEL COMPARISON

Manufacturer	Model	Fuel Source	Purchase Cost	Range (mi.)	Availability
eLion	Lion	Battery Electric	$330,000	75-100	Available
Blue Bird	Vision Electric	Battery Electric	$350,000	120	Limited
Thomas Built (Daimler)	Saf-T-Liner eC2	Battery Electric	$375,000	120	2020
Motiv	Starcraft eQuest	Battery Electric	$335,000	65-100	Limited
Navistar (IC Bus)	chargE	Battery Electric	NA	120	2020
Blue Bird	Vision Diesel	Diesel	$100,000	NA	Available
Blue Bird	Vision Gasoline	Gasoline	$100,000	NA	Available
Blue Bird	Vision Propane	LPG	$110,000	NA	Available
Thomas Built (Daimler)	Saf-T Liner Propane	LPG	$115,000	NA	Available
Blue Bird	Vision CNG	CNG	$130,000	NA	Available
Thomas Built (Daimler)	Saf-T Liner CNG	CNG	$125,000	NA	Available

This table provides estimates for the upfront cost of Class C school bus models for several fuel types. Electric models have a higher purchase price than other fuel types.

Sources: [23, 24]

TRUCKS

Commitments from large companies and technological progress has accelerated growth in the electric trucks sector. Despite this acceleration, some reports do not expect longer range medium- and heavy-duty electric trucks to account for more than four percent of the U.S. market through 2025 [25]. Electrification of last mile delivery trucks is expected to advance more rapidly. Companies like UPS and Ikea have committed to electrifying a portion of their fleets [26]. Local delivery trucks and regional haul freight trucks are two primary targets for electrification. While there is growing interest in electrifying long-range freight trucks, many early models have not reached commercial markets yet and the ICF estimates that the average electric truck costs twice as much as a conventional fuel alternative. However, electric trucks are expected to reach price parity in terms of TCO by 2025 [11]. The ICF report finds that a majority of current trucks on the market best serve urban and suburban regions on routes less than 100 miles a day. Despite this range limit, these trucks could potentially cover up to 40 percent of the movement of goods around the country [11].

TABLE 4: U.S. ELECTRIC TRUCK DEPLOYMENT BY MANUFACTURER AS OF EARLY 2019

Manufacturer	Trucks Deployed	Trucks on Order or Pre-Order
BYD	30	Unknown
Chanje	100	900
Daimler	50	Unknown
Motiv	50	Unknown
Nikola	0	14,000
Tesla	0	475+
Xos (Thor)	2	Unknown
Toyota	10	Unknown
Workhorse	50	950
Volvo	23	Unknown
Total	**315**	**16,325+**

This table includes both the deployed electric trucks and orders placed with different manufacturers. Electric truck deployment could expand significantly as these orders are fulfilled.

Sources: Various sources provided inline in table including both manufacturer press releases and media coverage.

Tesla reports that their Semi can achieve just below two kilowatt-hours per mile or roughly three times fuel economy of the average diesel Class 8 truck on an energy equivalent basis [6]. Overall fuel cost savings are likely to increase as freight truck travel is expected to increase up to 50 percent in certain parts of the country by 2030 [11]. This means that electrifying the medium- and heavy-duty sector is required in order for states like California to reach greenhouse gas emission reduction goals. With total lifecycle emissions 70 percent below comparable diesel vehicles under an average grid electricity mix, electric trucks can have a significant role in addressing climate and public health challenges in the transportation sector [11]. Table 4 presents a rough estimate of electric trucks in operation and on order from several manufacturers.

MEDIUM-DUTY TRUCKS

At the end of 2018, ICF estimated that there were roughly 300 medium-duty electric trucks operating in the United States. This category includes trucks in Classes 4 through 6. A majority of these were attributed to the UPS fleet and service local deliveries. Many of these trucks have been tested in New York, where all-electric trucks are eligible for $15 million in vouchers through the Voucher Incentive Fund. In California, 203 HVIP vouchers have been issued for electric delivery trucks. In total, the HVIP program has awarded 555 vouchers for electric trucks and shuttle buses [3]. Investment in California has generated partnerships between regional air quality management agencies and manufacturers like Volvo seeking to develop and introduce new electric trucks to the market in 2020 [27]. Even with these new investments, the number of medium-duty electric trucks in operation is still likely below 1,000. Table 5 presents a comparison of different delivery trucks with many of the prices yet to be determined due to limited commercialization.

According to the forthcoming study from ICF mentioned above, current California electric Class 6 regional haul trucks with a subsidy of approximately $140,000 have a TCO roughly $20,000 lower than diesel alternatives with subsidies. With only the LCFS in place, TCO savings increase to $135,000 in 2030 [17].

TABLE 5: DELIVERY TRUCK MODEL COMPARISON

Manufacturer	Model	Vehicle Type	Fuel Type	Cost	Range (mi.)	Availability
Volvo	FL Electric	Medium Truck	Electric	NA	186	Limited
Volvo	FE Electric	Refuse Truck	Electric	NA	124	Limited
BYD	Class 6	Medium Truck	Electric	NA	124	Pilot
Chanje	V8100	Delivery Van	Electric	NA	150	Limited
Workhorse	NGEN-1000	Delivery Van	Electric	$50,000	100	Limited
Workhorse	E-100	Medium Truck	Electric	$130,000	100	Limited
Daimler (FUSO)	eCanter	Delivery	Electric	NA	60-100	Pilot
Daimler (Freightliner)	eM2	Medium Truck	Electric	$400,000	200-230	2021
Daimler (Mercedes)	eActros	Medium Truck	Electric	NA	125	2021
Daimler (Mercedes)	eSprinter	Delivery Van	Electric	NA	70-100	Pilot

Manufacturer	Model	Vehicle Type	Fuel Type	Cost	Range (mi.)	Availability
Motiv Power	EPIC	Delivery Van, Chasses	Electric	$180,000	90-100	Limited
Renault	Trucks D	Medium Truck	Electric	NA	75	Pilot
Daimler (Freightliner)	M2106	Medium Truck	Diesel	$77,000-$100,000	NA	Available
Daimler (Mercedes)	Sprinter	Delivery Van	Diesel	$47,000	NA	Available

This table provides estimates for the upfront cost of different delivery truck models including several fuel types. Electric models have a higher purchase price than other fuel types.

Sources: Links to manufacturer websites included above in the table. [11].

CLASS 8 TRUCKS

Class 8 freight truck electrification efforts are also increasing, albeit at a slower pace. To date, California has issued less than 10 vouchers for electric Class 8 freight trucks [3]. The HVIP program is not the only source of funding for heavy-duty trucks and overall, 40 electric drayage trucks are being tested in California drawing on funding sources including the California Climate Investments cap-and-trade program [11]. Daimler recently announced a commitment to electric trucks with plans to have 50 models available for testing by the end of the year [28]. Tesla is looking to compete in this sector and has already brought in pre-orders for their Semi from companies including Walmart, Pepsi, and UPS [29]. Table 6 provides a comparison between Class 8 truck models that show missing gaps in price comparisons due to low levels of commercialization.

TABLE 6: CLASS 8 FREIGHT TRUCK MODEL COMPARISON

Manufacturer	Model	Fuel Type	Cost	Range (mi.)	Availability
Daimler	eCascadia	Electric	NA	250	2021
Daimler	E-Fuso Vision One	Electric	NA	200	2021
Tesla	Semi	Electric	$150,000-$180,000	300-500	2020
Nikola	TWO	Electric	NA	300-400	2022
Volvo	VNR Electric	Electric	NA	NA	2020
Xos (Thor)	ET-One	Electric	$150,000-$250,000	100-300	2020
BYD	T9	Electric	$300,000	124-167	2020

Manufacturer	Model	Fuel Type	Cost	Range (mi.)	Availability
Peterbuilt (TransPower)	ElecTruck	Electric, Hybrid	$250,000	50-100	2020
Cummins	Aeos	Electric, Hybrid	NA	100-300	2020
Daimler (Freightliner)	Western Star 4700	Diesel	$134,000	NA	Available
Freightliner	Cascadia 113	CNG	$160,000	NA	Available
Nikola	ONE	Fuel Cell	NA	1,200	2022
Toyota (Kenworth)	FCET	Fuel Cell	NA	300	Pilot

This table provides estimates for the upfront cost of different freight truck models including several fuel types. Electric models have a higher purchase price than other fuel types.

Source: Links to manufacturer websites included above in the table. [11].

According to the forthcoming study from ICF mentioned above, current California electric Class 8 short haul trucks with a public subsidy of approximately $200,000 have a TCO $190,000 lower than diesel alternatives. With only the LCFS in place, TCO savings do not change in 2030 [17].

CONCLUSION

Growth in the medium- and heavy-duty EV market is likely to accelerate in the United States and other leading auto markets around the world through the next several years. Operators of electric transit buses, the only vehicle category within this market to reach full commercialization, are already experiencing significant fuel cost and maintenance savings for their buses. Analyses from Bloomberg New Energy Finance (BNEF) and the ICF expect the cost of battery technology and charging infrastructure to decline over the next several years [2, 11]. This could improve the lifetime cost analysis of electric school buses and trucks as they near price parity with conventional models around 2025. Until then, public investment and support from electric utilities will continue to play a significant role in the adoption of electric trucks and buses. These topics will be covered in detail in the following resources.

REFERENCES

[1] R. Scriben, "Battery electric truck market to grow 20% in 2019 despite dip in 2018," Interact Analysis, 2019. [Online]. Available: https://www.interactanalysis.com/hybrid-electric-trucks-and-buses-2019/. [Accessed May 2019].

[2] Bloomberg New Energy Finance, "Electric Buses in Cities," 28 March 2018. [Online]. Available: https://data.bloomberglp.com/professional/sites/24/2018/05/Electric-Buses-in-Cities-Report-BNEF-C40-Citi.pdf. [Accessed May 2019].

[3] California Hybrid and Zero-Emissions Truck and Bus Voucher Incentive Project, "Deployed Vehicle Mapping Tool," 2019. [Online]. Available: https://www.californiahvip.org/tools-results/#program-numbers. [Accessed May 2019].

[4] New York State Energy Research and Development Authority, "Truck Voucher Incentive Program," New York State Energy Research and Development Authority, 2019. [Online]. Available: https://truck-vip.ny.gov/. [Accessed May 2019].

[5] California Air Resources Board, "Low Carbon Fuel Standard," 2019. [Online]. Available: https://www.arb.ca.gov/fuels/lcfs/lcfs.htm. [Accessed June 2019].

[6] U.S. Department of Energy, "Average Fuel Economy of Major Vehicle Categories," Alternative Fuel Data Center, 2018. [Online]. Available: https://afdc.energy.gov/data/10310. [Accessed May 2019].

[7] Atlas Public Policy, "State Tracking Dashboards," Atlas EV Hub, 2019. [Online]. Available: https://www.atlasevhub.com/materials/vw-environmental-mitigation-fund-tracking/#_state-tracking-dashboards. [Accessed May 2019].

[8] J. O'Dea, "How Can We Get More Electric Trucks on the Road?," Union of Concerned Scientists, 23 April 2019. [Online]. Available: https://blog.ucsusa.org/jimmy-odea/how-can-we-get-more-electric-trucks-on-the-road. [Accessed May 2019].

[9] H. Tabuchi, "California Requires New City Buses to Be Electric by 2029," New York Times, 14 December 2018. [Online]. Available: https://www.nytimes.com/2018/12/14/climate/california-electric-buses.html. [Accessed May 2019].

[10] E. Popel, "Breathing Easy," 17 August 2018. [Online]. Available: https://calstart.org/wp-content/uploads/2018/11/Breathing-Easy-August-2018.pdf. [Accessed May 2019].

[11] ICF, "Medium- and Heavy-Duty Electrification in California Literature Review – Final Report," December 2018. [Online]. Available: https://www.atlasevhub.com/resource/medium-and-heavy-duty-electrification-in-california-literature-review-final-report/. [Accessed 2019 May].

[12] Atlas Public Policy, "Public Agency Requests & Funding Awards," Atlas EV Hub, 2019. [Online]. Available: https://www.atlasevhub.com/materials/public-agency-requests-funding-awards/. [Accessed May 2019].

[13] Proterra, "Proterra and Mitsui Create $200 Million Credit Facility to Scale Proterra Battery Leasing Program," Proterra, 16 April 2019. [Online]. Available: https://www.proterra.com/press-release/proterra-and-mitsui-co-ltd-create-200-million-credit-facility-to-scale-proterra-battery-leasing-program/. [Accessed May 2019].

[14] Atlas Public Policy, "Public Funding Awards Dashboard," Atlas EV Hub, July 2019. [Online]. Available: https://www.atlasevhub.com/materials/public-agency-requests-funding-awards/. [Accessed July 2019].

[15] California Air Resources Board, "Bus Prices Analysis," February 2017. [Online]. Available: https://arb.ca.gov/msprog/ict/meeting/mt170626/170626buspricesanalysis.pdf. [Accessed June 2019].

[16] Proterra, "35-Foot Catalyst," Proterra, 2016. [Online]. Available: https://www.proterra.com/products/35-foot-catalyst/. [Accessed May 2019].

[17] ICF, "Medium- and Heavy-Duty Electrification in California - Technology Assessment," 2019.

[18] VEIC, "Investing for Maximum Impact: VW Mitigation Funds in Transit and School Bus Fleets," VEIC, 4 May 2018. [Online]. Available: https://www.veic.org/media-room/insights/insights/2018/05/04/investing-for-maximum-impact-vw-mitigation-funds-in-transit-and-school-bus-fleets. [Accessed May 2019].

[19] J. Gerdes, "School Districts Rolling Out Electric Buses as Economics Improve: 'It's Time to Switch'," Greentech Media, 15 November 2018. [Online]. Available: https://www.greentechmedia.com/articles/read/school-districts-rolling-out-electric-buses#. [Accessed May 2019].

[20] U.S. Public Interest Research Group, "Paying for Electric Buses," [Online]. Available: https://uspirg.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf. [Accessed May 2019].

[21] Proterra, "Proterra and Thomas Built Buses Debut Electric School Bus," Proterra, 30 October 2018. [Online]. Available: https://www.proterra.com/press-release/proterra-and-thomas-built-buses-debut-electric-school-bus/. [Accessed May 2019].

[22] S. Marcacci, "Electric Buses Can Save Local U.S. Governments Billions. China's Showing Us How It's Done.," Forbes, 21 May 2018. [Online]. Available:

https://www.forbes.com/sites/energyinnovation/2018/05/21/electric-buses-can-save-americas-local-governments-billions-chinas-showing-us-how-its-done. [Accessed May 2019].

[23] VEIC, "Types of Electric School Buses," November 2018. [Online]. Available: https://www.veic.org/Media/success-stories/types-of-electric-school-buses.pdf. [Accessed June 2019].

[24] New York State Office of General Services, "School Buses: Award Summary," 2018. [Online]. Available: https://www.ogs.state.ny.us/purchase/spg/pdfdocs/4052423000Summary.pdf. [Accessed 2019 June].

[25] S. Carpenter, "Electric Trucks to be Tiny Part of Market for Years, Report Says," 1 April 2019. [Online]. Available: https://www.trucks.com/2019/04/01/electric-trucks-fraction-market-for-years/. [Accessed 2019 May].

[26] K. Fehrenbacher, "How IKEA plans to deliver its goods via electric trucks and vans," GreenBiz, March 29 2019. [Online]. Available: https://www.greenbiz.com/article/how-ikea-plans-deliver-its-goods-electric-trucks-and-vans. [Accessed May 2019].

[27] TruckingInfo, "Volvo Reveals Electric VNR Model to Go On Sale in 2020," TruckingInfo, 2018 11 December. [Online]. Available: https://www.truckinginfo.com/321067/volvo-reveals-electric-vnr-model-to-go-on-sale-in-2020. [Accessed May 2019].

[28] K. Fehrenbacher, "The big truck makers are starting to take electric trucks seriously," GreenBiz, 25 April 2019. [Online]. Available: https://www.greenbiz.com/article/big-truck-makers-are-starting-take-electric-trucks-seriously. [Accessed May 2019].

[29] M. Matousek, "Tesla has a new customer for its electric Semi — here are all the companies that have ordered the big rig," Business Insider, 25 April 2018. [Online]. Available: https://www.businessinsider.com/companies-that-ordered-tesla-semi-2017-12. [Accessed May 2019].

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