U.S. CLASS 8 TRENDS, FORECAST, ANALYSIS & INSIGHT

ALTERNATIVE FUELS QUARTERLY

REPORT VERSION PUBLISHED Q3 2019

2019 LAWRENCE R. KLEIN BLUE CHIP AWARD WINNER

Contributor to Blue Chip Economic Indicators and WSJ Economic Forecast Panel

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SAMPLE REPORT OVERVIEW:

Thank you for your interest in ACT Research and our work. The objective of this sample report is to share an understanding of the market, economy, and insight to analysis at the time of publication. We share this report from 2017 for market context, assessment of our historical and current data recordings, and a look into the market indicators gathered.

Alternative Fuels Quarterly

This quarterly report covers the price of alternative fuels and natural gas, information related to alternative fuels infrastructure, equipment, retail sales, and other important happenings.

With this report, you will receive trends, forecast, analysis, and details about alternative fuel prices, infrastructure, Class 8 NG retail sales (current and forecast), alternative fuel equipment/R&D, and highlights from ACT's N.A. On-Highway Commercial Engine OUTLOOK. Additionally, we share an overview of the past alternative fuel news, special information about alternative fuel developments. This report comes with a spreadsheet linked to regulatory information with details of the current and pending regulations that will impact alt fuel-powered CV demand.

Click the buttons below to access more!

REPORT VIDEO

With your subscription to the *Alternative Fuels Quarterly*, you will gain access to our report dashboard. Below is a listing of this dashboard and the support material you will receive with your report.

1.PDF of Current Month Report

2.Key Items of Note
- A. Fuel Prices
- B. Fuel/Charging Infrastructure
- C. New NG Truck Sales Data
- D. NG Truck Adoption Forecasts
- E. Equipment Prices, Products & Technology Developments
- F. Quarterly Highlights from ACT's Engine OUTLOOK
- G. Regulations
- H. Alternative Fuel in the news analysis/recap
- I. Glossary

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"I would recommend ACT Research to anyone that's looking for in-depth insight into what's happening in the commercial vehicle markets. The expertise and knowledge that goes into the service they provide, there's not a better solution, in my opinion, for commercial vehicle data than ACT Research."
- Jeff Trent, Mahle

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HIGHLIGHTS

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FUEL PRICES

- Electricity/kWh has remained in the $0.13 range.
- CNG has remained relatively constant since July of 2018, at around $2.21/GGE.
- Longer term, diesel prices, much like LNG, have been more volatile, swinging from $2.47/gallon two years ago, to $3.24 mid-2018, and now at $3.04/gallon.
- Shorter term, however, diesel prices have ranged narrowly from $2.98/gallon at the beginning of this year to $3.04 at the end of this July.

FUELING/CHARGING INFRASTRUCTURE

- Since January 2019, 43 HD-accessible and 7 MD-accessible CNG stations have shuttered their doors, been temporarily removed from service, or possibly been converted to private operations.
- Compared to September of 2018, the number of existing, publicly-accessible HD CNG stations has contracted more than 2% y/y, or 16 stations, while the MD publicly-accessible station count has declined nearly 6% y/y, or 10 stations.
- On a year-over-year basis, planned private CNG stations have risen nearly 42%, or 5 stations, while planned public stations have declined 23%, or 8 stations.
- Planned public CNG stations that are HD-accessible have declined more than 19% year-over-year, with total planned CNG stations in the US dropping a less significant 6% compared to September of 2018.

NA CLASS 8 NG RETAIL SALES

- June RS fell 14% m/m and 19% compared to the previous June, but remained positive, up 28%, on a ytd basis.
- RS in July remained negative m/m, down 11%, but were able to return positive readings longer term, rising 30% y/y and holding steady at +28% ytd.
- August RS still showed positive readings against longer term comparisons, up 13% y/y and 27% ytd, but they dropped sequentially, down 23%.

ALT FUEL EQUIPMENT

- The price tag for Tesla's Semi was announced at $150,000 for the 300-mile range truck and $180,000 for the 500-mile version. Using Musk's promised $0.07/kWh recharging rates, the payback is estimated at two years.
- Carrying nine cement blocks, which are estimated to weigh around 4,000 pounds each, by a Tesla Semi with a flatbed trailer estimated to weight about 11,000 pounds, the reported GCVW of 75,000 pounds results in an estimated 28,000-pound curb weight on the tractor.
- Like CNG, BEVs will quickly dominate the passenger vehicle markets, through the Classes 6-7 segments of transport buses, and refuse trucks; getting enough kilowatts stored on anything larger gets tricky.

ACT'S ENGINE OUTLOOK HIGHLIGHTS

- Several vocational engine families, including diesel options, have demonstrated the capability of achieving NOx emissions 50-75% below today's standards.
- BP released an annual energy report, showing that the global economic growth in 2018 fueled a strong increase in energy consumption. That resulted in a corresponding increase of CO_2 emissions.
- Natural gas' advantage to dramatically reduce emissions is important in markets like California.

ALT FUEL NEWS

- The EPA revoked California's Clean Air Act waiver and a legal battle began.
- NG adoption efforts seem to be receiving significant investment and are continuing.
- Propane adoptions and product introductions also continue to be made.
- Battery electric power appears to be setting all the groundwork to allow for higher adoption rates.
- Hydrogen fuel cell vehicles are not just possible, but are gaining converts and some converts are putting dollars behind their conversion.

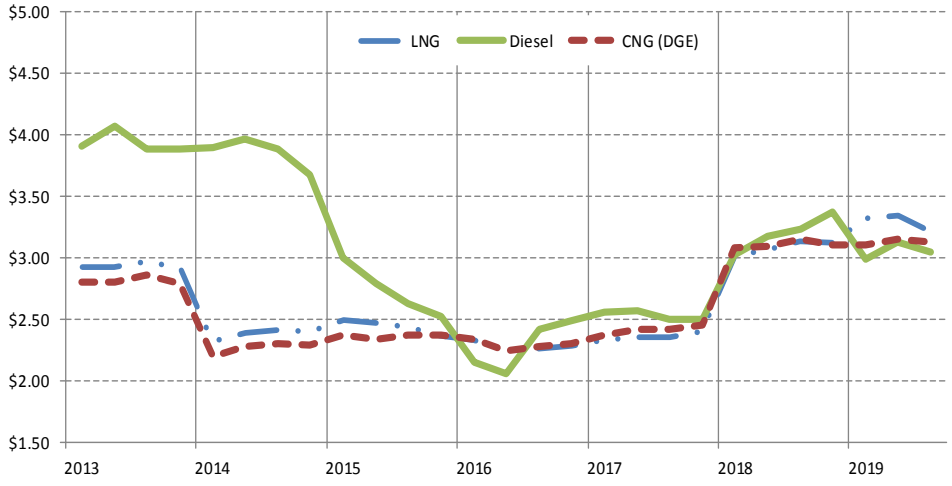
TODAY'S NG PRICE STORY: Based on data we are now receiving via ACT's proprietary industry surveys, the graph below is presented as a reflection of NG pricing, partially using fleet averages and publicly-available online databases, as well as adjustments for fuel efficiency of currently available diesel engines. Because the $0.50/gallon tax credit was not available for 2018, despite being retroactively reinstated for 2017 at the end of 2017, it is excluded from the data that feed into the graph. We do not assume the credit will be retroactively reinstated for 2018 at this point nor implemented for 2019, but we will make the necessary adjustments if that does happen, as we are aware of proposed legislation to reinstate it.

While some Q3'19 fuel prices continued to increase, others were flat or recorded a slight decrease. Compared to the beginning of 2019, as well as to the past two sets of July data, electricity per kilowatt has remained in the $0.13 range. CNG has remained relatively constant since July of 2018, at around $2.21/GGE, which is a $0.05 increase from July of 2017. CNG per DGE and adjusted for efficiency has averaged $3.12 thus far in 2019. LNG has fluctuated in the $2.68 to $2.76 range this year, now at its highest point of the year, and considerably more expensive than the $2.52 being paid in July of 2017 or the $2.60 cost per DGE last July. Using ACT's mpg efficiency adjustment, LNG/DGE has averaged $3.29 to-date in 2019. Longer term, diesel prices, much like LNG, have been more volatile, swinging from $2.47/gallon two years ago, to $3.24 mid-2018, and now at $3.04/gallon. Shorter term, however, diesel prices have ranged from $2.98/gallon at the beginning of this year to $3.04 at the end of this July.

Notes: ACT has learned from various sources that there are virtually no new LNG customers from the heavy duty CV segment, with sales only to legacy fleets like UPS, which have private stations. Additionally it should be noted that the use of diesel fuel also requires the use of diesel exhaust fluid (DEF), which means additional per gallon costs. Thus, the true per-gallon used cost is higher than the pump price of diesel alone.

OTHER FUEL PRICES: The evaluation of any fuel as a possible energy source for one's fleet must include the consideration of price (retail, wholesale, and/or contracted rates) versus publicly-available rates. We have heard of fleets paying $1.50/DGE for NG, and heard that some are paying even less. Additionally, it is important for fleets to compare and analyze fuels on an apples-to-apples basis, including energy content. While ACT learns more about this, and given that not all fuels are currently being used to power Class 8 vehicles in the US, we thought it might be helpful to provide the alternative fuel price tables from the DOE's Alternative Fuels Data Center (see the following page) to aid in the discussion, as well as a quarter-to-quarter and year-to-year comparisons.

U.S. Retail Fuel Prices per DGE
NG Adjusted Price for Tax & Fuel Efficiency
Q1 '13 - Q3 '19



Source: Alternative Fuel Price Reports (AFDC, US DOE), EIA , www.cngnow.com, ACT Research Co., LLC Copyright 2019

FUEL PRICES

National Average Price Between January 1 and January 31, 2019	
Fuel	Price
Biodiesel (B20)	$2.8/gallon
Biodiesel (B99-B100)	$3.57/gallon
Electricity	$0.12/kWh
Ethanol (E85)	$1.99/gallon
Natural Gas (CNG)	$2.19/GGE
Liquefied Natural Gas	$2.71/DGE
Propane	$2.91/gallon
Gasoline	$2.27/gallon
Diesel	$2.98/gallon

Source: Alternative Fuel Price Report, January 2019 and U.S. Energy Information Administration

National Average Price Between April 1 and April 30, 2019	
Fuel	Price
Biodiesel (B20)	$2.88/gallon
Biodiesel (B99-B100)	$3.51/gallon
Electricity	$0.13/kWh
Ethanol (E85)	$2.31/gallon
Natural Gas (CNG)	$2.22/GGE
Liquefied Natural Gas	$2.68/DGE
Propane	$2.9/gallon
Gasoline	$2.76/gallon
Diesel	$3.09/gallon

Source: Alternative Fuel Price Report, April 2019 and U.S. Energy Information Administration

National Average Price Between July 1 and July 31, 2019	
Fuel	Price
Biodiesel (B20)	$2.86/gallon
Biodiesel (B99-B100)	$3.62/gallon
Electricity	$0.13/kWh
Ethanol (E85)	$2.36/gallon
Natural Gas (CNG)	$2.21/GGE
Liquefied Natural Gas	$2.76/DGE
Propane	$2.83/gallon
Gasoline	$2.76/gallon
Diesel	$3.04/gallon

Source: Alternative Fuel Price Report, July 2019 and U.S. Energy Information Administration

National Average Price Between July 1 and July 31, 2017	
Fuel	Price
Biodiesel (B20)	$2.49/gallon
Biodiesel (B99-B100)	$3.22/gallon
Electricity	$0.13/kWh
Ethanol (E85)	$1.99/gallon
Natural Gas (CNG)	$2.15/GGE
Liquefied Natural Gas	$2.52/DGE
Propane	$2.84/gallon
Gasoline	$2.26/gallon
Diesel	$2.47/gallon

Source: Alternative Fuel Price Report, July 2017 and U.S. Energy Information Administration

National Average Price Between July 1 and July 30, 2018	
Fuel	Price
Biodiesel (B20)	$3.06/gallon
Biodiesel (B99-B100)	$3.55/gallon
Electricity	$0.13/kWh
Ethanol (E85)	$2.35/gallon
Natural Gas (CNG)	$2.22/GGE
Liquefied Natural Gas	$2.60/DGE
Propane	$2.81/gallon
Gasoline	$2.88/gallon
Diesel	$3.24/gallon

Source: Alternative Fuel Price Report, July 2018 and U.S. Energy Information Administration

National Average Price Between July 1 and July 31, 2019	
Fuel	Price
Biodiesel (B20)	$2.86/gallon
Biodiesel (B99-B100)	$3.62/gallon
Electricity	$0.13/kWh
Ethanol (E85)	$2.36/gallon
Natural Gas (CNG)	$2.21/GGE
Liquefied Natural Gas	$2.76/DGE
Propane	$2.83/gallon
Gasoline	$2.76/gallon
Diesel	$3.04/gallon

Source: Alternative Fuel Price Report, July 2019 and U.S. Energy Information Administration

NG STATION COUNTS CONTRACTED IN Q3'19: According to the US Department of Energy's Alternative Fuels Data Center (AFDC), there were 898 public CNG stations open in the US in mid-September 2019, 80% of which can accommodate a HD vehicle. The LNG station count at the same time was 64, with all able to serve Class 8 vehicles. This translated to eight fewer public CNG and two fewer public LNG stations than were operational just three months earlier, in mid-June.

Since January 2019, 43 HD-accessible and 7 MD-accessible CNG stations have shuttered their doors, been temporarily removed from service, or possibly been converted to private operations. That said, since January, 41 more HD-accessible , but 29 fewer MD-accessible private CNG stations are in the record books, suggesting that some may have converted from public to private, but the difference may also be that a portion of those MD private stations now categorize themselves as HD-accessible locations.

Compared to September of 2018, the number of publicly-accessible HD CNG stations has contracted more than 2% y/y, or 16 stations, while the MD publicly-accessible station count has declined nearly 6% y/y, or 10 stations.

While the existing station count continues to decline, planned CNG stations are a different and mixed story. On a year-over-year basis, planned private CNG stations have risen nearly 42%, or 5 stations, while planned public stations have declined 23%, or 8 stations. On a y/y basis, planned public CNG stations that are HD-accessible have declined more than 19%, with total planned CNG stations in the US dropping a less significant 6% compared to September of 2018. Interestingly, this quarter, data show an increase of nearly 55% y/y for planned, private HD-accessible CNG stations. That said, it is important to note that means an increase of just 6 stations.

The illustration below provides readers with additional detail, showing the y/y percentage change in the number of existing and planned US CNG stations over the past five years. Additionally, ACT spoke with one CNG station owner recently who conveyed that volumes at his station have dropped 66% from where they were in 2015. As a retail CNG station, that's probably also true across other same-store sales, while volumes might be increasing with fleets using private stations, if they have increased the size of their fleet in the same period.

EXISTING U.S. CNG STATIONS

	PRIVATE			PUBLIC			TOTALS			Y/Y %
DATE	LD	MD	HD	LD	MD	HD	PRIVATE	PUBLIC	GRAND	Change
Sep-15	69	183	450	26	205	632	702	863	**1565**	
Sep-16	79	187	502	25	212	710	768	947	**1715**	9.6
Sep-17	56	162	525	25	193	734	743	952	**1695**	-1.2
Sep-18	42	153	538	20	177	731	733	928	**1661**	-2.0
Sep-19	33	114	547	16	167	715	694	898	**1592**	-4.2
y/y % chng	-21.4	-25.5	1.7	-20.0	-5.6	-2.2	-5.3	-3.2	-4.2	

PLANNED U.S. CNG STATIONS

	PRIVATE			PUBLIC			TOTALS			Y/Y %
DATE	LD	MD	HD	LD	MD	HD	PRIVATE	PUBLIC	GRAND	Change
Sep-15	2	2	45		17	105	50	137	**187**	
Sep-16	2		36		6	73	42	87	**129**	-31.0
Sep-17		1	25		4	40	27	50	**77**	-40.3
Sep-18		1	11		2	31	12	35	**47**	-39.0
Sep-19			17		1	25	17	27	**44**	-6.4
y/y % chng		-100.0	54.5		-50.0	-19.4	41.7	-22.9	-6.4	

NOTES:

Total may differ from individual aggregate because accessibility is not always identified in planned stations.

Temporarily unavailable stations excluded.

ADDITIONAL ALT FUEL INFRASTRUCTURES: The following table is a baseline by which future growth of alternative fuels will be measured. This information is presented with a few caveats for the reader. First, we do not know how many of the various stations can accommodate an HD vehicle. Second, the table includes only publicly-accessible alternative fuel stations. Third, it is important to realize that some may be single-point refueling, while others may have multiple refueling points as part of a single station location.

EXISTING U.S. PUBLIC ALT FUEL STATIONS							
DATE	CNG	LNG	ELECTRIC**	BIODIESEL	ETHANOL	HYDROGEN	PROPANE*
Jul-18	933	74	18,153	196	3,280	35	455
Aug-18	928	74	18,344	196	3,292	36	477
Sep-18	928	75	18,617	187	3,296	36	473
Jul-19	903	67	21,820	211	3,387	41	639
Aug-19	900	65	22,017	195	3,390	41	668
Sep-19	898	64	22,607	193	3,472	40	708
September y/y % chng	-3.2	-14.7	21.4	3.2	5.3	11.1	NA

* Change in AFDC State Information Website 4/18
ACTR estimates approximately **12k HD-accessible diesel stations** currently operating in the US

PLANNED U.S. PUBLIC ALT FUEL STATIONS							
DATE	CNG	LNG	ELECTRIC**	BIODIESEL	ETHANOL	HYDROGEN	PROPANE
Jul-18	36	38	40	2	23	27	5
Aug-18	36	38	41	2	24	27	4
Sep-18	35	38	38	2	24	27	3
Jul-19	29	38	27	1	59	25	2
Aug-19	29	38	27	1	62	25	2
Sep-19	27	38	30	1	55	25	2
September y/y % chng	-22.9	0.0	-21.1	-50.0	129.2	-7.4	-33.3

NOTES: Source: US Dept of Energy, Alternative Fuels Data Center

Only CNG & LNG specifically designate HD accessibility. All LNG stations are HD accessible.

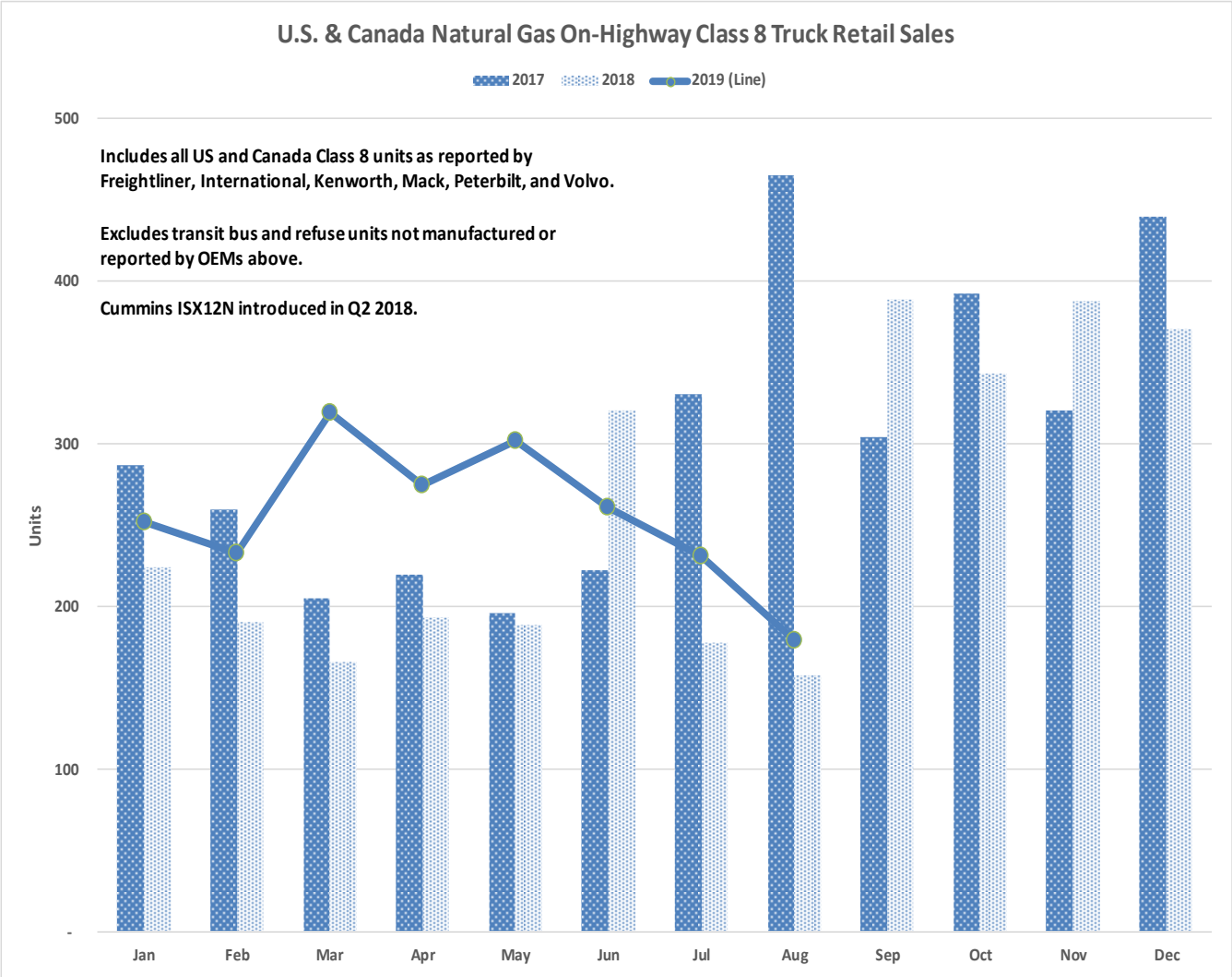
Of the number listed above, 715 existing CNG stations are HD accessible, while 25 planned CNG stations are HD accessible.

****It is assumed that 99.9% of these stations are primarily for car charging, although some may be situated to allow for larger vehicle charging now and that the availability will increase as demand warrants.**

AUGUST UP 27% YTD: Sales of natural gas-powered vehicles so far this year saw their peak in March and have fallen sequentially in four of the past five months. Looking at the most recent month (August), sales fell m/m (-23%), but bested the year-ago period (+13%). YTD gains have dwindled over the past three months, settling at a 27% gain. Through the first eight months of 2019, OEMs have sold 2,052 natural gas-powered Class 8 units. For comparison, total US Class 8 sales were up 18% for the same period.

WHO'S BUYING?: Based on news released in the popular press, natural gas vehicle purchases appear to continue to be dominated by refuse fleets, as well as transit and school bus operators. Among truckers, it appears as though the majority of incremental volume came from current natural gas vehicle users replacing units or increasing their fleet size.

TOTAL VS. REPORTED SALES DIFFER: Because of additional units (from low volume OEMs), the volume above falls short of the number of Cummins Westport (CWI) natural gas engine shipments. CWI shipments totaled just shy of 3,750 units in the first half of 2019, up 27% compared to the same period in 2018. (Note: There is a time lag between shipments of an NG engine to an OEM, the assembly of the NG fueled truck, shipment of the truck to the selling truck dealer, and delivery of the vehicle to the end customer. Additionally, a portion of natural gas engines are destined for export markets.)



CURRENT HD NG FUELED TRUCK MARKET EDGING UP: NG-powered Class 8 truck and bus sales are expected to improve moderately on a unit basis, rising from 5,373 units in 2018 to 5,726 units in 2019. As a percentage of the total market, NG is likely to decline, with the NG share of the total market estimated at 2.0%, compared to an estimated 2.1% in 2018. The release of the Cummins-Westport ISX12N near-zero engine appears to be resulting in an increase in sales of natural gas-powered vehicles. Despite the small decrease in penetration, a forecast increase in the overall Class 8 market will result in a moderate gain in the actual number of natural gas sales in 2019. In 2019, the total US Class 8 market (including NG buses) is forecast at 281,600 units (retail sales), an increase of 8% from 2018. Low diesel fuel prices and the anticipation of other alternative choices have conspired to slow natural gas sales expectations.

U.S. Class 8 Natural Gas Adoption Rates

	2015e	2016e	2017e	2018e	2019 F	2020 F
FOR HIRE:						
TL	1%	1%	1%	1%	1%	1%
LTL	1%	1%	1%	1%	1%	1%
Expedited	1%	1%	1%	1%	1%	1%
Owner Operator	0%	0%	0%	0%	0%	0%
TOTAL FOR HIRE	**1%**	**1%**	**1%**	**1%**	**1%**	**1%**
PRIVATE	1%	1%	2%	1%	1%	2%
VOCATIONAL:						
Refuse	35%	33%	25%	18%	18%	23%
Municipal	2%	3%	3%	3%	3%	4%
Construction	1%	0%	0%	0%	0%	0%
Other	0%	0%	0%	0%	0%	0%
TOTAL VOCATIONAL	**5%**	**5%**	**4%**	**3%**	**3%**	**4%**
TOTAL TRUCK	**2%**	**2%**	**2%**	**1%**	**1%**	**2%**
Transit Bus	30%	31%	32%	33%	32%	33%
NG SHARE OF CLASS 8 TRUCK AND BUS SALES	**3%**	**3%**	**3%**	**2%**	**2%**	**3%**

U.S. Class 8 Natural Gas Vehicle Sales (Units)

	2015e	2016e	2017e	2018e	2019 F	2020 F
FOR HIRE						
TL	492	510	426	414	418	401
LTL	131	140	128	124	125	120
Expedited	109	94	102	83	84	80
Owner Operator	-	7	7	-	10	7
TOTAL FOR HIRE	**732**	**751**	**663**	**622**	**637**	**609**
PRIVATE	**911**	**851**	**1,065**	**1,105**	**1,195**	**1,102**
VOCATIONAL						
Refuse	3,223	2,365	1,795	1,676	1,832	1,708
Municipal	142	160	160	179	232	217
Construction	248	154	155	150	190	140
Other	12	10	12	15	19	14
TOTAL VOCATIONAL	**3,624**	**2,689**	**2,121**	**2,021**	**2,273**	**2,079**
TOTAL TRUCK	**5,267**	**4,291**	**3,849**	**3,748**	**4,106**	**3,789**
Transit Bus	1,500	1,545	1,595	1,625	1,620	1,645
TOTAL CLASS 8 NG TRUCK AND BUS SALES	**6,767**	**5,836**	**5,444**	**5,373**	**5,726**	**5,434**

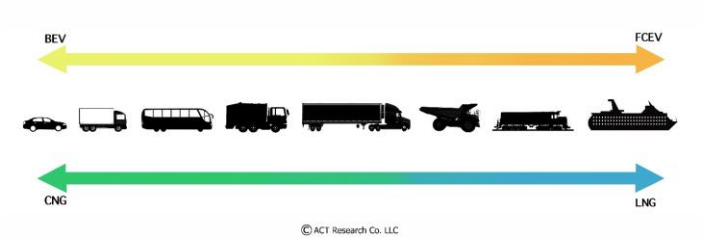
Source: ACT Research Estimates

HEAVY DUTY EVs IN BETA MODE: The Tesla Semi has been spotted a number of times pulling a trailer with supplies to the Gigafactory, although the payload weight was always an unknown. Now, there have been sightings with cement blocks on a flatbed, which allows for some speculation on ***Weight*** and ***Performance***. Critics have been very vocal regarding the payload impairment of trying to squeeze 1MW of juice onto a tractor chassis. Many are claiming a Facebook post from the CHP proves the Tesla Semi will weigh considerably more than a diesel tractor. We revisit the COST, RANGE, and WEIGHT discussions with the new information in mind.

COST: The cost was revealed two years ago when Elon Musk unveiled the Tesla Semi. The price tag was announced at $150,000 for the 300-mile range truck and $180,000 for the 500-mile version. Using Musk's promised $0.07/kWh recharging rates, the payback is estimated at two years. However, for fleets that get paid by the ton, there remained a nagging question: How much will it weigh? The cost to these weight-sensitive fleets may exceed an acceptable payback. (Click here for ACT Research's Alt Fuels Calculator for comparisons).

RANGE: While there is no hard data released from Tesla on range performance, the CHP trooper quotes the driver as saying "…meeting or exceeding range estimates." It is unknown if the red tractor is the 300- or 500-mile beta truck. One blogger suggested it is the 300-mile tractor and the 500-mile variant is 5,000 pounds heavier, with batteries, and could theoretically hook to the same trailer and gross-out at 80,000 pounds.

WEIGHT: Carrying nine cement blocks, which are estimated to weigh around 4,000 pounds each, on a flatbed trailer estimated to weight about 11,000 pounds, the reported GCVW of 75,000 pounds results in an estimated 28,000-pound curb weight on the tractor. That is about 10,000 pounds more than a diesel equivalent tractor would weigh.



BATTERY – FUEL CELL TUG-O-WAR: Much like the early days of natural gas, battery technologies must determine where the dividing line is for higher horsepower applications. Eight or nine years ago, the debate for HD trucking was how to store natural gas on trucks, CNG or LNG. As illustrated in ACT's graphic above, the HD trucking segment is often in the middle of such tug-of-wars due to its position in the fuel consumption spectrum. Like CNG, BEVs will quickly dominate the passenger vehicle markets, through the Classes 6-7 segments of transport buses, and refuse trucks; getting enough kilowatt-hours stored on anything larger gets tricky. HD electric vehicles will need many extra kilowatts. And kilowatt storage doesn't come cheap. It costs approximately $225/kWh and weighs around 10-15 lbs/kWh, which displaces payload. The alternative is to run with a fuel cell and fewer batteries (FCEV). The trade-off comes with the requirement to store hydrogen in extremely high-pressure tanks, which also adds weight. So, on one side of the debate you'll find Tesla, Xos (formerly known as Thor Trucks), and BYD arguing for BEVs, while Nikola, Toyota, Hyundai and others seem to favor FCEVs. Both technologies require their own unique infrastructure; one being the power grid's need to update its distribution management system, while fuel cells will require a major roll-out of hydrogen refueling centers. While the infrastructure isn't usually the headline, it remains top of mind for fleets evaluating adoption.


PHOTO: Peterbilt


PHOTO: Freightliner


PHOTO: Nikola


PHOTO: Tesla Semi

	DIESEL	NATURAL GAS (NG)	HYDROGEN FUEL CELL (FCEV)	ELECTRIC (BEV)
COST	$140,000 Capital Cost $42,000 Residual Value $3.13/gal diesel fuel $2.75/gal DEF	$185,000 Capital Cost $40,000 Residual Value $2.48/dge of nat gas $300/DGE in tanks	$350,000[1] Capital Cost Residual Value N/A $1.50/dge H2[2] $0.11/kWh[2] $300/kWh in batteries	$180,000 Capital Cost $0 Residual Value Analysis[7] $0.11/kWh[3] $100/kWh in batteries[6]
RANGE	1,000+ miles Dual Alum. Tanks Dense fueling network	600 miles 120DGE tank package Adequate fueling network	1,000+ miles 350kWh storage H2 fueling network not yet available	500 miles 1MW storage Supercharging stations not yet available
WEIGHT[4] (Battery Pack Weight/kWh)	20,000 lbs.	21,000 lbs.	20,000 lbs. 10-15#/kWh	24,000 lbs. 10-15#/kWh
PERFORMANCE[5]	6.5 – 8.5 mpg 425-600 hp 1,650 ft-lb $0.10/mi maintenance	5.0 – 6.0 mpge 400 hp 1,400 ft-lb $0.115/mi maintenance	13-15 mpge 1,000 hp 2,000 ft-lb $0.00/mi maintenance[1]	17-19 mpge 1,000 hp 2,000 ft-lb $0.08/mi maintenance
Operating Cost per Mile[ACT]	**$0.775**	**$0.926**	**$0.72** [1]	**$0.726**

[1]Actual out-right purchase price is not yet public. Nikola offers a flat $5,000-$6,000/mo payment which includes: lease payment, fuel, maintenance and replacement cost. At end of lease Nikola will replace with new unit.

[2]Hydrogen and kWh prices shown are for estimates only. Nikola and Nel Hydrogen (Norway) to begin building the first of many Hydrogen stations. Also, the kWh cost is a national average of the cost of electricity and could vary based on peak demand, energy source, etc.

[3]Elon Musk made a promise of $0.07/kWh if charged on a Tesla Supercharger.

[4]As analyzed by weight of Model S battery packs (see also teslarati article or BU101).

[5]Maintenance references from testimonials, including biased forecasters and actual fleet experiences. Logic includes reduced cost for lube, oil & filter as well as significant reduction in brake pads, etc. All maintenance may not be included.

[6]After touring the Gigafactory, one Tesla analyst predicted costs of batteries on Tesla Semi to be as low as $100/kWh.

[7] Some analysts suggest the battery life on a Tesla semi will be exhausted after one trade cycle. ACT's AFQ for Q2 – 2019 takes the residual value after 5 years to zero considering 5 years to be a common trade cycle.

[ACT] To see ACT Research calculator inputs click here. Click on calculator to visit the site and enter your own inputs.

ENGINE TRENDS, NEW PRODUCT OFFERINGS & ALTERNATIVE FUEL UPDATES

- Compared to emission controls on MY 2010 US diesel trucks, today's compact aftertreatment systems are 40% lighter, 60% smaller, and substantially less expensive.
- Several vocational engine families, including diesel options, have demonstrated the capability of achieving NOx emissions 50-75% below today's standards.
- A wide variety of technology options can be deployed on HD engines and vehicles to reduce engine-out NOx, while improving fuel economy to reduce the total cost of ownership.
- Cummins will stop producing the 5.0L turbocharged V8, rated at 310 horsepower and 555 lb-ft of torque.
- Concern is increasing about future supply shortages of key materials needed for electric vehicle batteries.
- Canada's Minister of Natural Resources announced a $4.6-million investment for building 92 EV fast chargers in its coast-to-coast network

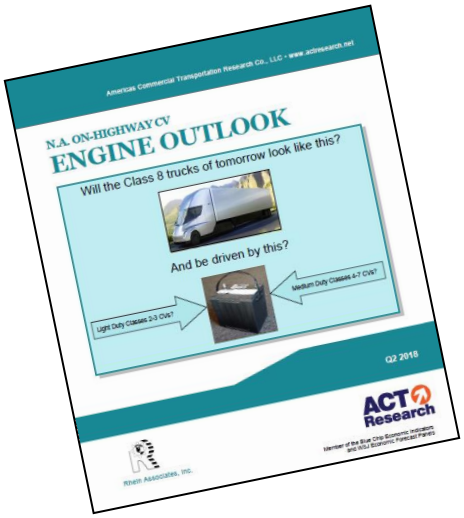
REGULATORY ENVIRONMENT

- Oregon senators voted 16-11 in favor of a bill regulating diesel trucks in the Portland metro area.
- BP released its annual Statistical Review of World Energy, showing that the global economic growth experienced in 2018 fueled a strong increase in energy consumption. That resulted in a corresponding increase of CO_2 emissions.
- The EPA is proposing an advanced biofuel volume requirement for 2020 of 5.04 billion gallons.

MARKET ANALYSIS - FORECASTS

Natural Gas

- Production of natural gas-powered trucks peaked in 2014, in response to high diesel fuel pricing, but declined as diesel prices fell.
- Natural gas' advantage to dramatically reduce emissions compared with diesel trucks is important in markets like California.



For more information about the
N.A. On-Highway CV ENGINE OUTLOOK
and to receive a free sample, click here.

ON THE ROAD: EV CHARGING & VW FUNDING

In early October, ACT personnel attended an electric vehicle charging infrastructure workshop, hosted by the Indiana Volkswagen Environmental Mitigation Trust Committee.

Primarily focused on electric adoption in the passenger vehicle/light-duty market, agenda topics spanned the gamut from OEM planning to midwestern VW EV implementation strategies, and from national charging infrastructure to infrastructure development and destination charging, as well as general sessions to make sure audience members had the same minimal level of understanding.

While much EV-specific information was presented, one could also walk away with the impression that it is déjà vu all over again, especially if one has spent any time considering the adoption of other alternative fuels, particularly natural gas, in the past ten years or so. And that's what the remainder of this page is going to consider…the similarities and differences in the EV adoption discussion versus the past NG adoption discussions.

Although it is tempting to assert that we should begin at the beginning, that is actually one of the challenges and one of the similarities…the chicken and the egg discussion. What is first required for adoption, the vehicles or the infrastructure to recharge/refuel? This circular argument seems to end at the fact that both need to develop simultaneously. And given that there is a cost to each, with required return on investment necessary, it is easy to see why the early adopter markets are the same for EV and NG…densely-populated urban areas. This is true for light or passenger vehicles powered by alternative fuels because of the obvious economies of scale and opportunities to share expenses, but it is also true for the heavier, commercial vehicles, such as buses, delivery vans/trucks, and waste-hauling trucks, because of the same considerations, as well as due to the return-to-base nature of these applications.

Another discussion at the early October meeting was the speed of EV charging, which mirrored the alternative fuel and industry conversations of not-so-many years ago about natural gas. How fast can we refuel an NGV? Is the nearest station or the station on our route slow-fill or fast-fill? In the case of EV, though, the question was slow-charge or fast-charge.

The third similarity was total cost of ownership (TCO). What are the initial costs of the alternative-fueled (alternative-powered) vehicles and how long would it take to recover the investment costs? Additionally, what other costs are factored into the equation…maintenance, tanks, inspections, and battery life cycles. On top of these considerations, for any vehicle, alternative-powered or traditionally powered, there is the counter argument: How long do people WANT to keep the vehicle anyway, given that new technology is constantly being developed or refined and improved? Does a fleet need and traditionally keep a vehicle, such as a school bus or a waste hauler, for many years, or does a fleet, such as those used in delivery applications, trade units more frequently because of the miles accumulated, because of the new, more efficient technologies available, or because of other factors, such as newer vehicles to attract and retain drivers? And what about the components, like batteries and NG tanks, and their relationship to vehicle trade cycles? Does it matter if the tanks last 25 years if the vehicle's life is only five or ten? Does it matter if the vehicles life is five or ten, if the batteries will only last as transportation power for three to five years, depending on the application's duty-cycle demands?

Despite all the similarities between EV and NGV adoption at comparable intervals, there is at least one major difference: The VW Environmental Mitigation Funds. As reported previously in this report, money from the Volkswagen settlement was divided into three separate mitigation programs to benefit consumers, states, and national zero-emission vehicle (ZEV) efforts. The total settlement of $14.7 billion included $10 billion to be spent on vehicle buyback and modification for consumers, with $2.9 billion set aside for states via the Environmental Mitigation Trusts and the remaining $1.8 billion to be spent over a ten-year period to support increased use of ZEV technology in the US. That said, NG efforts may also benefit from these funding opportunities, but there is no guarantee, as each state has been given the opportunity to develop its own program for use and distribution of the VW settlement money, meaning some may want to promote NGV, other EV, and others ZEV regardless of the way the zero emission is delivered. States also have the option of making funds available for vehicle purchases, infrastructure, or both.

Learn more about the settlement funding & uses:

https://vwclearinghouse.org/about/

https://www.vwenvironmentalmitigationtrust.com/

https://www.electrifyamerica.com/our-plan

REGULATIONS AND FUNDING: In 2013, California was granted a waiver by the EPA to set its own state emission standards. As of September, the EPA revoked California's Clean Air Act waiver and a legal battle began. The waiver was revoked, even though as recently as July 2019 a consortium of OEMs (Ford, BMW of North America, Volkswagen of America and Honda) agreed on a framework for an alternative path to clean vehicles standards nationwide, which would reduce GHG emissions by an additional 30% and cleaner air by 2026. Thirteen other states already follow the standards, including Colorado, whose Air Quality Control Commission voted 8-1 in August 2019 to adopt a Zero Emission Vehicle Standard. The new standard requires more automakers to sell more than 5% ZEVs by 2023 and more than 6% ZEVs by 2025. Additionally, the Colorado Energy Office has set aside $100,000 and is seeking bids for life-cycle assessments to understand and quantify the benefits, costs and other considerations of a Low Carbon Fuel Standard for that state.

The Governor of California, Gavin Newsom, is not letting this slow his agenda. In September, shortly after the "waiver kerfuffle," he signed an executive order to leverage the state's pension investment portfolio by directing many state agencies to update overall operations and transportation investments to leverage the state's purchasing power in advancing climate goals. This amounts to the $5 billion portfolio of the California State Transportation Agency being invested toward reduction of GHG emissions and reversing the trend of increased fuel consumption. He also signed into law two bills, SB210 and SB44, designed to strengthen emission standards for trucks, semis and other high-pollution vehicles. But even as the EPA seeks to loosen the Clean Air Act, it pursued Hyundai Construction Equipment Americas Inc. for violating Title II of the CAA when the company "stockpiled engines that met outdated emission standards and then sold heavy construction equipment with these engines in them." In September this year, the EPA and Hyundai reached a settlement of $47 million for civil penalties.

Payouts from the VW Diesel Emissions Mitigation Trust are appearing in various states as part of the move away from diesel. But a closer look at some of its use reveals something peculiar for anyone who is an emission-reduction purist. The first round of funding in Indiana $9.8 million will be used across 23 counties for 4 electric buses, 18 diesel buses, 60 propane buses, 47 diesel on-road vehicles, 31 CNG vehicles, 5 electric on-vehicles, 4 diesel engines, and 10 electric powered pieces of equipment (36% diesel). In Pennsylvania, 34 transportation projects will receive $8.4 million for: 56 electric vehicle chargers, 2 electric vehicles, 81 diesel vehicles, 20 CNG-powered vehicles and 2 propane-powered vehicles (50.3% diesel). The South Dakota Department of Environment and Natural Resources (DENR) is also on its first round of VW funding, $507,000, and it will be applied in the form of rebates of up to 25% of the purchase price for 2018 or newer engines certified to EPA standards, 35% of the purchase price for engines meeting the CARB low-NOx standard, or 45% of the purchase price of an electric truck.

But to be fair, it is worth mentioning that there are a number of other states attempting to truly meet the spirit of the VW mitigation trust. Maine's trust funding of $5.1M is being used along with state matching funds to provide rebates of $1000 - $2000 for qualifying plug-in hybrid and battery powered electric vehicles. New York has announced $20 million in funding - $9M of which was VW-related funding for replacement of diesel vehicles with electric, hybrid-electric, CNG or propane powered Classes 3-8 vehicles and Classes 3-8 battery electric buses. South Carolina is allocating the majority of its VW settlement to 78 propane school buses, 2 Proterra electric buses and charging stations, and 1 CNG transit bus. Florida is focusing much of the $166 million toward electric vehicles and the associated charging infrastructure.

For a variety of reasons, there appears to be more awareness about the impact of harmful emissions such as GHG and NOx. This is evidenced by the number of local, state and congressional activities focused on energy sourcing, emissions and transportation. The governor of Oregon teamed with RNG stakeholders to sign SB 98, allowing Oregon utility providers to acquire RNG on behalf of customers, with the goal of adding about 30% RNG into the state's pipeline system. In

September, the governor of Minnesota, by Executive Order, directed his pollution control agency to implement standards design to combat climate change and protect public health among other things. One of the standards is the low-emission vehicle standard and the other is the zero-emission vehicle standard. Also in September, the Mayor of Albuquerque, New Mexico signed an Executive Instruction to move all eligible city vehicles to low- or no-emission vehicles, and the California Energy Commission approved a $95 million plan for clean transportation investments focused on hastening ZEV adoption rates. The plan supports the CARB ruling made in early July requiring all fixed route shuttles in 13 of California's largest airports to be ZEV by 2035. The Senate Environment and Public Works Committee in July 2019 unanimously advanced a bipartisan infrastructure bill, S. 2302, which includes funding for electric, electric-hybrid and hydrogen-powered refueling infrastructure.

NATURAL GAS: As alluded to in the last *AFQ* edition, natural gas (NG) adoption efforts seem to be receiving significant investment and are continuing. An idea that must have been pleasing to Mr. T. Boone Pickens, a longtime advocate and champion whose efforts led to early NG growth and development in the United States. Pickens passed away in September. Even in Canada, the interest in NG is growing. PrinceGeorgeMatters.com reported in August that the high price of diesel and the government scrutiny of emissions has caused truck operators in British Columbia to take an interest in NG as an alternative fuel. Renewable natural gas (RNG) continues to receive increased attention, and the RNG industry in North America has grown 150% in the last five years, according to the RNG Coalition, resulting in at least 101 RNG production sites across the continent. The expansion in RNG creation continues today, as does the necessary infrastructure: In August, Indianapolis broke ground on the construction of a new landfill gas-to-RNG plant owned by Kinetrex Energy; In Milan Missouri, Smithfield Foods Inc. completed the construction of a natural gas transmission line connected to the Smithfield hog farm in an effort to accelerate a 25% reduction of the company's GHG emissions by 2025. The project is expected to expand over the next 10 years, spanning 90% of its operations across the nation; Clean Energy Fuels Corp., a provider of RNG for fleets, announced it had won numerous contracts to provide RNG or expand RNG refueling infrastructure across multiple sectors in California. Additionally, the company opened a NG fueling station in Hunts Point, New York, the first of its kind in the state to offer RNG to medium- and heavy-duty vehicle fleets. Outside of RNG production, the adoption of CNG is continuing, as evidenced in how some states are choosing to use part of the VW Mitigation trust funds allocated to them, as well as in some recent company announcements: Total Transportation Systems Inc. has acquired 40 CNG vehicles for port operations; Omaha Metro recently ordered 10 CNG buses from New Flyer, in addition to the 19 ordered in 2018; Birmingham Jefferson County Transit Authority in Alabama announced in August that the City Council had approved the purchase of 15 CNG buses; In British Columbia, Canada, the Transit Corporation issued an order for 68 CNG transit heavy-duty buses; Bunzl Canada Inc., a global distributor, is also testing CNG trucks for delivery in Ontario. Even UPS, a large logistics company, is part of the action; they announced an investment of $450 million to add 6,000 CNG vehicles and supporting infrastructure through 2022. The company has a target of ensuring that 25% of vehicles purchased in 2020 run on alternate fuels. Part of this investment is to purchase 230 million gallons of RNG over the next 7 years.

PROPANE: While propane is not making a big splash in the news, we are certainly seeing continued propane adoptions and product introductions. A study by researchers at West Virginia University concluded that emissions measured from school buses powered by propane are significantly lower than emissions measured from diesel-powered buses. Specifically, NOx emissions fell by 96% and carbon dioxide by 13%, with a propane bus. Such results lend credence to propane adoption in bus applications, even if it is not zero emissions. The Rhoads Energy of companies in Pennsylvania announced in August that it plans to switch all gasoline and diesel vehicles in its fleet to propane by 2020; Acadia National Power

is acquiring 21 new propane buses for its fleet; Kansas City Public Schools integrated 155 new propane school buses from Blue Bird just before the new school year started in August; Columbia Falls School district also purchased 3 propane buses towards saving on cost and reducing GHG emissions; Nebraska's Department of Environment and Energy has awarded $2.6 million in rebates to schools across the state for replacement of older diesel school buses. So far, 10 are planning to purchase propane vehicles, but the remaining districts are purchasing newer diesel buses. The fueling infrastructure is just as important and to this end, U-Haul Moving & Storage of Casper Wyoming announced in September that it is now supplying propane, in addition to the moving vehicles.

ELECTRIC: Battery electric power appears to be setting all the groundwork to allow for higher adoption rates. First, in September, Tesla battery researchers announced they have a new cell type that could last 1 million miles in "robot taxis." If this is true, the question is how well does this translate to commercial vehicles (Classes 4-8)? And could we possibly be looking at long haul electric vehicles? The necessary strategic alliances to support electric power are taking shape. Volvo trucks and Samsung announced in July that Samsung SDI will be developing battery packs for Volvo electric trucks. Toyota and BYD announced an agreement to jointly develop battery electric vehicles, with BYD holding strength in battery development. In September, Daimler Truck and Buses also announced a supply agreement with Contemporary Amperex Technology Co. Limited (CATL) for global battery cell modules to be used in electric series trucks. Cummins Inc., a powerhouse in its own right, announced a partnership with the University of California to understand effective reuse or repurposing of electric vehicle batteries. This could potentially provide an answer about what to do with all those batteries to come when electric vehicles finally start increasing in adoption. While OEMs are firming their supply chains, others are hedging their bets behind electric power by either investing significantly in EV manufacturers or placing notable orders. Rivian, an electric vehicle company, received $350 million in investment from Cox Automotive, after making a $500 million deal with Ford and $400 million deal with Amazon. In addition, Amazon will purchase 100,000 electric vehicles through 2030, with the first 10,000 on the road by 2022. This is a deliberate effort on the part of Amazon to use its scale and size to make a difference. In August, Dominion Energy Virginia announced plans for a significant electric school bus deployment of 1,000 buses by 2025 and 100% replacement of all diesel buses by 2030, in order to enhance grid reliability and provide cost savings to the school districts. The pharmaceutical company AstraZeneca, which has sites in the US, has announced plans to switch its 16,000-vehicle fleet globally to electric power, as it joined the EV100 initiative, an initiative dedicated to accelerating climate action.

States and cities are also taking action. North Carolina now has a draft plan to boost the number of electric vehicles on the road in that state to 80,000 by 2025, and the City of Ann Arbor announced plans to make its fleet electric by next year. Even though, there is still a lack of choice on electric product currently available, some early adoptions are underway, mostly in the bus segment and with at least one OEM: IndyGo in Indianapolis has selected BYD to provide 13 K11 electric buses for the rapid Red Line bus service that just started operation, with 31 of these buses expected to be in operation by the end of this year; Penske Truck Leasing and NFI took delivery of two Freightliner eCascadia Class 8 trucks in August; the Massachusetts Bay Transportation Authority has received 3 of 5 electric buses for its Silver Line Routes; Societe de transport del Laval, a public transit system in Quebec, is currently testing and validating an electric bus from New Flyer, with plans to receive 9 additional units; and Trinity Metro in Fort Worth, Texas, has awarded New Flyer a contract for four heavy-duty buses. A view of product announcements shows that other than buses, most commercial electric vehicles will be in production by 2020 through 2021, and the infrastructure and legislations in each state to support these adoptions are currently being studied and/or planned.

HYDROGEN-ELECTRIC: Two years ago, any discussion about hydrogen being a feasible power solution was met with "pie-in-the-sky eye rolls." Not anymore. The recent Zero Emission Bus Conference in San Francisco revealed that hydrogen fuel cell (HFC) vehicles are not just possible, but are gaining converts and some converts are putting dollars behind their conversion. In September, Nikola Corp. received $250 million in a strategic investment and partnership with CNH Industrial N.V. toward efforts to accelerate adoption of fuel-cell technology. This is in addition to Bosch being selected as Nikola's strategic partner for fuel system and battery expertise, and a partnership with Hanwha for leadership in renewable energy and solar panel manufacturing. In the same month, Cummins Inc. closed on its acquisition of Hydrogenics Corp., a fuel cell and hydrogen technology provider. With this acquisition, Cummins is signaling its belief in the viability of hydrogen as a transportation power source for electric energy. Some of the questions around the infrastructure are beginning to be planned. For instance, the California Occupational Safety and Health Standards Board has approved high-pressure ground storage tanks from Hexagon, which are said to last 20 years, minimize operating costs, and maximize uptime. Given today's globalized markets, the Chinese government's $17 billion of funding behind hydrogen vehicles should not be overlooked. The government is currently subsidizing each HFC passenger vehicle 200,000 yuan and commercial vehicles 500,000 yuan. This kind of support is the stuff that makes initial adoption rates. It is expected that hydrogen technology will reach price parity with diesel engines by 2030, which is the time China desires to have 1 million hydrogen vehicles on the roads. And in the US, the Fixing America's Surface Transportation (FAST) Act authorized $305 billion through 2020 to make infrastructure upgrades, including provisions for an alternative fuel corridor that includes hydrogen infrastructure.

REGULATORY PIPELINE: ALTERNATIVE FUELS

Regulation	Agency	Intro Date	Status	Impact	Milestones	Next Steps	Proposed Implementation
U. S. Federal - Emissions							
GHG-2	EPA &NHTSA	Jun-15	Final rule published EPA seeking repeal of glider kit rules Courts put trailer rules into abeyance.	~~CY2018 Trailers~~ **CY2018 Glider Kits** MY2021 Tractors Implementation through 2027	TTMA suit with US DC District Court of Appeals 12/2/16 EPA Requests OMB to repeal glider kit GHG-2 regs 10/20/17 Court implements stay on trailers 10/27/17 California says it will implement GHG-2 unilaterally Court rules glider kit rules must be implemented	TTMA files 8/6 to get schedule from EPA, EPA responds 8/16; will meet with TTMA EPA/TTMA met on 9/21/18 to rvw process TTMA seeking similar NHTSA meeting TTMA withdraws their 8/6 motion 9/24 **Next update on trailers due Nov'19**	CY2018 trailers stayed by US Appeals Court indefinitely; repeal strong possibility glider kit regs to be repealed MY2021 tractors still as scheduled
Ultra-Low NOX Standards for On-Road HD Trucks & Engines	South Coast Air Quality Mgmt District (SCAQMD) and others	Jun-16	Petition to US EPA	Request EPA to revise standards of 0.2 grams brake horsepower-hour (g/bhp-hr) to 0.02 g/bhp-hr	Petition sent to EPA 6/16	April 6th training requirement; digital training course not yet posted by FDA	
Mid-term Evaluation of GHG Emissions for MY 2022-25 Light Duty Veh.	EPA	Apr-18	Being examined	Revise 2025 auto fuel efficiency standards	Published in Federal Register. EPA proposes holding to 2020 levels	CARB and others filed case to prevent 2025 target overturn. See info here	TBD
Clean Air Act waiver process for California	EPA	Apr-18	Administration Proposal	Administration seeks to revoke waiver ability for California in Clean Air Act	Bush Admin (2007) formally denied waiver renewal Obama Admin reinstated waiver	Any attempt by Trump Admin would likely result in multi-year legal fight	TBD
Cleaer Trucks Initiative (CTI)	EPA	Nov-18	Proposal	NOX reduction goals impact HD engines	Future rulemaking announced 11/13/2018 Separate from GHG II greenhouse gas effort	Publication in 2020	TBD
Regulation	**Agency**	**Intro Date**	**Status**	**Impact**	**Milestones**	**Next Steps**	**Proposed Implementation**
U.S. State							
California EXECUTIVE ORDER B-48-18	California Statewide	Jan-18		Tightens existing 2030 goals	Target of 5 million ZEV by 2030	Proposal to State legislature for funding	
Washington State Road Use Charge Test Pgm	WA DOT Road usage Steering Committee	Early 2018	Seeking participants	Pay by mile	1000 participants signed up	**Seeking 2000 participants for pilot program**	Early 2018
CA Road Charge	California Senate Bill 1077	Jun-16	Propose 5,000 driver test alternate revenue collection versus fuel taxes	Pay by the mile, time-based permit, or mileage based permit	06/2016 CTA (Cal. Truck Assoc.) volunteers. California re-opens voluntary sign-up for more volunteers Nov 1, 2016	Pilot launched 7/1/16, concluded 3/31/17 **Find final report at: http://www.dot.ca.gov/road_charge/resources/final-report/docs/final.pdf**	Legislative attention in 2018
CA Sustainable Freight Action Plan	CA Multi Agency	May-16	CARB published State Strategy for the State Implementation	Goal to transition freight transport system to zero-emissions technology	7/2015 Exec Order B-32-15 directs plan to be developed by 7/2016	Plan publication 3 Pilot projects announced 8/2/17	2023
California GHG-2 for Trailers & Gliders	California	2017	CARB sets 2020 implementation for state	Unilateral implementation. May expand applicability to out-of-state fleets operating in CA	Will state need EPA Clean Air Act waiver?	EPA's current "revisiting" of rules pushed CARB actions.	MY2020
Ports of Long Beach and LA approve Clean Air Stds	CARB	Jul-18	Implementation 10/1/2018	Any new trucks added to Ports Drayage Truck Registry (PDTR) must be MY 2014 or newer	Trucks currently enrolled in PDTR not impacted		10/1/2018
Illinois recommends Truck Platooning be allowed	Competitive Enterprise Institute	7/20/2018		Driver must still be in truck		State action needed to implement recommendation	
Innovative Clean Transit 2018	State of California	8/7/2018	Proposal published; Public review on 9/28/18	Convert Transit Bus Fleet to ZEB (Zero Emission Buses) by 2040	Sets ZEB purchase mandates for replacement buses starting in 2023; 100% replacements ZEB starting 2029 100% of bus fleet to be zero-emission by 2040	Public hearing 9/27/2018 Next Board Mtg 1/24/2019	Proposed to start 1/1/2023
California Phase 2 GHG Trailer Certification	California	2017	Effective on 1/1/20 for MY2020 trailers	Trailers sold in CA must meet requirements OEMs will need to certify to CA standards and receive Exec Order to sell in CA (Note: this is sell in CA, not "use" in CA like TRU regs)	2/7/19 Phase 2 GHG rulemaking approved 3/25/19 CARB workshop 4/1/19 Certification Applications may be submitted 5/2019 "FAQ" finally posted 7/2019 Approved aero devices list posted 3/31/21 2020MY reports due from OEMs	OEMs must certify trailers meet new regs. Significant certification efforts and warranty requirements for OEMs	1/1/2020

REGULATORY PIPELINE: ALTERNATIVE FUELS

Regulation	Agency	Intro Date	Status	Impact	Milestones	Next Steps	Proposed Implementation
U.S. State (continued)							
Ditch Dirty Diesel Act (SB-44)	California	Intro 12/3/2018 Published 3/21/2019	Proposal introduced into CA state senate	Phase out diesel MD and HD trucks and buses	Mandate CARB to develop strategy to meet federal ambient air quality standards. Strategy to be developed by 1/1/2021	CA Senate approval	1/1/2021
Block Registration of Older Vehicles	California	Feb-18	1/1/2020 Implementation	CA domiciled vehicles Sliding timeframe for implementation 1/1/20 GVW 7&8 MY'00 & older, GVW 4,5,6 MY'04	"Health-based" requirements Registration blocked for older vehicles not repowered with 2001 or newer engine or those falling outside MY ranges	Dryage and solid waste hauling equipment given slightly longer implementation schedule Only impacts CA domiciled vehicles	1/1/2020
Clean Trucks, Clean Air (SB210)	California	9/20/2019	"Heavy-Duty Vehicle Inspection Program" (HDVIP) Signed into law	All out-of-state Class 4 - 8 non gasoline vehicles must be smog compliance checked to operate in state	Two year "pilot" program underway to develop program "specifics"	Pilot Program Potential Fed EPA involvement	Full implementation in 2021/22
New TRU Regulation Draft	California ARB	4/2016 but workshops in Aug/Sep'19	Under Development	Reduce impact of areas where TRUs and TRU gen sets congregate	Public Workshops occurred in late Aug and Sept 2019	TRU registration fees to cover program cost	TRU registration to start in 2022
Plug-in Eletric Vehicle and Alt Fuel Tax Credits	Colorado	7/2/2018	Credits available for purchase/leae/conversion	LD/MD/HD vehicles through 2026	Vehicles registered in Colorado		In place
Canada Federal							
Transportation 2030: Green and Innovative Transportation		Jul-05	Strategic plan	Address impact of all modes of transport on climate conditions	Budget support started in 2017 Federal Budget		
Mexico Federal							
Revise NOM-044 HD Emissions Standards	SEMARNAT	Jan-14	Under development	HD vehicles would need to meet EPA 2010 or Euro VI standards Impact through MY2037	12/2014 Mexico SEMARNAT approved update	Still determining the level of standards to be implemented.	Expect Euro V 7-18& Euro VI 2020
Adequate supply of ULSD fuel	PEMEX	In time to support NOM-044 revision	In process	Needed to allow NOM-044 update to be implemented	2/2014 PEMEX commits to investment at all refineries	Continued investment by PEMEX ULSD availability still minimal **500ppm sulphur diesel sales banned as of 1/1/19 (currently 24% of consumption)** **PEMEX expects further delay in proposed implementation**	Ongoing, but well behind schedule **Domestic ULSD production only at 3 of 6 domestic refineries; 9% of domestic demand** **Additional ULSD imports needed**
Euro Engine Standard Implementation	SEMARNAT	Jul-05	Aligned with US standards with timing delay	Sets timing for intro of various engine/exhaust technologies	Current timeline: 7/1/2019 for EuroV 1/2/2021 Only Euro VI engines		

Highlight designates recently updated information

Alternative Fuels Data Center Laws database available here

Steps in the Federal Rule Making Process

ANPRM	Advanced Notice of Proposed Rule Making	Seeking input for development of rules
SNPRM	Supplemental Notice of Proposed Rule Making	Seeking addition input. Can happen before or after NPRM
NPRM	Notice of Proposed Rule Making	Proposal published in Federal Register, opens commentary period
IFR	Interim Final Rule	Infrequently used step before final rule publication
Final Rule		Starts the implementation clock; can be a 2 year horizon

Go here for a detailed review of the process

DOT	Dept. of Transportation	NHTSA	Nat'l Highway Traffic Safety Administration
EPA	Environmental Protection Agency	PEMEX	Petroleos Mexicano
FRA	Federal Rail Administration	SCAQMD	South Coast Air Quality Management District
HHS	Health & Human Services	SEMARNAT	Mexico's Secretariat of Environment and Natural Resources
IIHS	Insurance Institute for Highway Safety	TSB	Transportation Safety Board Canada
LVVR	Locomotive Voice and Video Recording	ULSD	Ultra Low Sulfur Diesel fuel
MCSAP	Motor Carrier Safety Assistance Program		

GLOSSARY OF ACRONYMS

A	
AFDC	Alternative Fuels Data Center (U.S. Dept. of Energy)
B	
BEV	Battery Electric Vehicle
BTU	British Thermal Unit
C	
CEV	Commercial Electric Vehicle
CNG	Compressed natural gas
COE	Cab over engine
CPM	Cost per mile
CRWPT	Cost, Range, Weight, Performance, Time
CWI	Cummins Westport Inc.
D	
DEF	Diesel exhaust fluid
DERA	Diesel Emissions Reduction Act
DGE	Diesel gallon equivalent
DING	Direct injection natural gas
DME	Dimethyl Ether
DOE	Dept. of Energy
DPF	Diesel particulate filter
E	
ECM	Electronic control module
EGR	Exhaust gas recirculation
EIA	Energy Information Administration
ELD	Electronic Logging Device
EPA	Environmental Protection Agency
EREV	Extended Range Electric Vehicle
EV	Electric Vehicle
F	
FCEV	Fuel Cell Electric Vehicle
G	
GGE	Gasoline gallon equivalent
GHG	Greenhouse gases
GHG2	GHG Phase 2 Regulations
H	
HD	Heavy duty (vehicle)
HEV	Hybrid Electric Vehicle
HOV lanes	High occupancy vehicle lanes
HPDI	High pressure direct injection
K	
Kw	Kilowatt
L	
LCFS	Low carbon fuel standard
LD	Light duty (vehicle)
LIBs	Lithium Ion Batteries
LNG	Liquefied natural gas
LTL	Less than truckload carrier
M	
Mcf	1,000 cubic feet
MD	Medium duty (vehicle)
MMBtu	Millions BTUs
O	
OEM	Original Equipment Manufacturer
OP	Opposed-piston engine
P	
PEV	Passenger Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PING	Pilot injection natural gas
PPM	Parts per million
R	
RFS	Renewable Fuel Standards Program
RNG	Renewable natural gas
ROI	Return on investment
RS	Retail sales
RIN	Renewable ID number
S	
SCR	Selective catalyst reduction
SING	Spark-ignited natural gas
T	
TCO	Total cost of ownership
TL	Truckload carrier
TRR	Technically recoverable shale gas reserves
U	
UOM	Unit of measure
V	
V2G	Vehicle-to-grid
VTEC	Volumetric excise tax credit
W	
WTI	West Texas Intermediate
Z	
ZEB	Zero-emission Bus
ZEV	Zero-emission Vehicle

ALTERNATIVE FUELS QUARTERLY

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