

# NPP

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### Nikola, Wiggins, Lion Truck & E-Marine



DELIVERING TOMORROW'S TECHNOLOGIES TO TODAY'S OEMS

# Nikola Motor's

HYDROGEN-ELECTRIC TRUCK BUILDER PLANS FACTORY, INTRODUCES NEW PRODUCTS. BY **CHAD ELMORE**

In the time since Nikola Motor Co. unveiled its hydrogen-electric Class 8 truck in Salt Lake City, the young company has reached several significant mile markers on its way to becoming a truck manufacturer – including demonstrating several functioning prototypes to thousands of customers, suppliers, supporters and fans at a recent event in Arizona.

For example. Since its public introduction

**Trevor Milton,**  
founder and CEO  
of Nikola Motor



in late 2016 (see the January 2017 issue of Diesel Progress), the Nikola team has selected and acquired land for its headquarters and factory campus. “When we set out to build a factory, part of my vision was to help an entire community,” said Trevor Milton, founder and CEO of Nikola Motor.

To that end, the company bought 400 acres in Saint Holdings LLC’s Inland Port Arizona business park in Coolidge, Ariz. – a town near Phoenix that was once heavily agricultural – where Milton anticipates he will add around 2000 jobs by 2024 and further transform Pinal County into a vehicle manufacturing hub. The site selection was the result of a two-year nationwide search.

Nikola was founded in Salt Lake City, and more than 130 team members have already set up shop in a temporary location in a Phoenix suburb while their new corporate home is built. The manufacturing facility is scheduled to be humming by 2022 and the company said it will be eventually be capable of building up to 35,000 trucks per year.

The company has signed a contract for test equipment, which will be used at its new home-base. AVL Test System Inc. will provide electrification and fuel cell test equipment for the first phase of a development



laboratory. AVL’s hardware – including a chassis dynamometer, fuel cell system and durability testbeds as well as a high-voltage battery test container – will be run with its lab management suite.

“It is critical that we move fast and have the best equipment as part of our truck development process,” said Mark Russell, president, Nikola Motor Co. “By creating our own facility, Nikola will be able to test and

The Reckless is a battery electric vehicle designed for military applications.



# next steps



<https://nikolamotor.com>



The Nikola Two day cab truck made several laps for attendees of Nikola World in Arizona.

validate its fuel cell components in half the time it would take others, as well as third-party labs."

The new facility is expected to enable the company to develop, validate and test its entire fuel cell system, including membrane electrode assemblies, stampings, stacks, and power electronics. The lab will also include climate-controlled chambers and dynamometers to test components independently or as a complete powertrain system.

"This lab will be filled with extremely talented fuel cell engineers and is a critical part in our truck development – enabling Nikola to set a new efficiency benchmark for heavy-duty fuel cell systems," said Milton. "It's a race to the finish line now for our team. Other OEMs have expressed interest in using Nikola's fuel cell drivetrain and hydrogen stations and we plan on making



The interior of the Nikola Two.

them available to other OEMs who share our vision."

## YEARS OF PRE-ORDERS

Nikola has orders on the books for its trucks: the company said it already has more than four years of production committed with pre-order reservations – about 13,000 trucks.

"We have a backlog of orders that exceeds what we can produce for several years, and our initial trucks will be dedicated to our partner customers," said Milton.

Last year, brewer Anheuser-Busch committed to up to 800 Nikola hydrogen-electric powered semi-trucks, which will make it a product development partner and

is ultimately expected to help the brewer meet its goal of converting its long-haul dedicated fleet to renewable power by 2025.

"Anheuser-Busch needs trucks that give them uptime and reliability," said Milton. "They need to be able to fill fast within a few minutes. They need to run trucks their continuously and they need

to be as light as a diesel. It has already been a great partnership."

For sales, service and support, Nikola has partnered with Ryder System Inc. and Caterpillar dealer Thompson Machinery, giving drivers access to more than 800 locations across North America.

Nikola Motor recently built one of the first hydrogen fueling stations in Arizona, which it will use to help with truck development. While the first one is private, the company plans to make hydrogen stations available to Nikola drivers as well as the general public – Honda, Toyota and Hyundai currently offer hydrogen cars to consumers in California.

Additional stations are expected to come

online in 2021 and by 2028 the company said it will have more than 700 hydrogen stations across the U.S. and Canada – with the earliest locations strategically positioned near fleets running Nikola trucks. The stations will produce hydrogen on-site aided by roof-top solar panels. Initially, each station will cover between 7 and 10 acres but that number is expected to decrease overtime.

A cross-industry group of companies that includes Air Liquide, NEL, Nikola Motor and Shell have signed a Memorandum of Understanding (MOU) for hydrogen fueling components, for the purpose of testing heavy-duty hydrogen fueling hardware to assist in standardization and speed to market for fuel cell electric trucks.

“Key members of the industry have joined forces to evaluate heavy-duty fueling hardware to make this a reality. The goal is to enable interoperability so that any heavy-duty FCEVs (fuel cell electric vehicles) can fuel at our hydrogen stations and we can fill at any of theirs, just like diesel today. This is a big first step,” said Jesse Schneider, executive vice president, Hydrogen & Fuel Cell Technologies, Nikola Motor. “Heavy-duty fuel cell trucks offer the same range as their conventional diesel counterparts and fueling hardware is being developed to fill in 10 minutes.”

## THE WORLD OF NIKOLA

In April, Nikola Motor Co. rented a facility in Scottsdale, Ariz., to host Nikola World. The

event showcased its latest semi-truck, the Nikola Two, which attendees could watch as it pulled a trailer around a closed course. Also on display was the Tre, a cabover truck designed for Europe (see the December 2018 issue of Diesel Progress). In addition, the company showed and operated battery-powered electric machines, including the Reckless utility vehicle designed for the military and the NZT (which stands for Net Zero Toll) off-highway recreational vehicle that has a direct-drive transmission.

The Reckless vehicle was driven on stage via remote control. “With virtually no sound and no heat signature, the Reckless provides new meaning to stealth and is defying all standards,” said Andrew Christian, Nikola Powersports vice president of Business Development and Defense. “We believe all military vehicles will transform to battery electric and hydrogen fuel cells in the future.”

Attendees also saw, for the first time, the Water Adventure Vehicle (WAV) concept. When and if it sees production, WAV would give the firm products in the on-highway trucking and recreational watercraft markets – making it an unusually diversified OEM.

“We at Nikola are creating the world’s first ‘wakeboard’ architecture, which enables us to push the limits in design and propulsion,” said Jordan Darling, vice president of Nikola Powersports.

The Two will be available in a 6x2 or 6x4 drive system that incorporates proprietary liquid-cooled electric-drive axles with 800v



AC motors on each wheel. The One and Tre trucks share the same drive system. The 250 kWh lithium-ion batteries that are carried between the frame rails are charged by combining hydrogen with oxygen in the fuel cell. Nikola said the drive system can put out 1000 hp and 2000 lb. ft. of torque.

“The truck is built entirely around a fuel cell,” said Schneider. “That means it is a purpose-built chassis which allows for a larger amount of energy storage on the vehicle to get a 600-mile range.”

While much attention has been placed on the Two’s fuel cell and lithium-ion power combination, the truck also showcases some of the latest technology available to commercial trucking.

“The Two is the only truck that I know that has full redundancy: redundant steering system, brake systems, electric motors and air disk brakes, and redundant controllers,” said Milton. “This allows for the future implementation of Level 4 or 5 autonomy. While we do not do autonomy on our own, each truck will be fully compliant and equipped with the hardware.”

## SUPPLIER RECOGNITION

Nikola World provided an opportunity for several of the company’s partners in the supply chain to talk about their role in the development process, including Pratt & Miller, Wabco, Meritor and Bosch.

From the latter, the trucks incorporate innovations in automation, connectivity and electrification. Teams from Bosch locations in the United States and Germany reportedly contributed more than 220,000 hours across



The Nikola NZT recreational vehicle is a battery electric vehicle; the company said production may start in 2021, a year earlier than the trucks.



The trucks use a proprietary electric axle with a motor for each wheel.

– the truck needed to do more than capture the imagination of drivers.

“That’s one of the things on the truck that we’re proud of at Bosch,” said Roycht. “This wasn’t a one-off project. The engineering work underneath the truck had to meet all the requirements for functional safety, for example. That’s all been done on this truck, and you can’t really show that off easily. But that’s what I think people in the industry will be most impressed by.”

Bosch engineers were on hand during Nikola World and were remotely monitoring Nikola Two as it made several laps under the Arizona sun.

“This project has helped us build a lot of competencies in this area,” said Roycht, “and I’ll be the first to admit we’ve gotten quite a lot out of it. Our engineering groups worked in areas that don’t have a playbook already written so that’s been a really neat experience.”

**NPP**

more than two years into the development of the trucks.

Onboard there is a Bosch Vehicle Control Unit (VCU) which provides high computing power for advanced functions and enables future innovations due to a scalable platform for the truck’s electronic architecture. Each truck will be connected to an operating system that provides real-time, over-the-air updates and monitoring. For the operator, Perfectly Keyless provides keyless vehicle access. Passive vehicle access and start are controlled by a digital key on a mobile phone.

Once the operator is in the seat (having entered through the center-mounted door behind the front seats), the Bosch Servotwin steering system offers speed-based steering assistance with active return and various driver assistance functions for semi-automated driving. Bosch said the electrical circuit replaces the previously needed second hydraulic circuit for commercial vehicles.

Bosch and mirror system specialist Mekra Lang also provided the Mirror Cam System, which replaces optical mirrors with digital cameras and ties into the vehicle’s communication system.

While specifics about the truck’s communication structure and electronic architecture is still under wraps, the system was called “state of the art.”

Bosch said its intent was to give the truck a level of connectivity that’s not yet been seen on a production truck.

“Data will be set up with secure protocols back and forth,” said Jason Roycht, vice president and regional business unit leader, Commercial Vehicles & Off-Road for Bosch in

North America. “A lot of that is not going to work without some major reinforcements to the J1939 CANbus based systems utilized in the industry today. That is part of what we’ve been doing with them – and that’s really been fun for our engineers. They’ve been designing from a blank sheet and looking at the challenge without any legacy designs to worry about. They’re talking about what will be considered ‘state of the art’ from 2022 to 2030 and what’s needed to build to that.

“This is engineering work we don’t usually do on a vehicle level. We do it on a system level, but looking at that across an entire vehicle presents new challenges, such as torque vectoring across four motors and balancing the battery energy and fuel cell.”

Because Nikola Motor intends to mass-produce the trucks, engineers needed to ensure safety was built in, as well



# Battery forklifts for produce

WIGGINS LAUNCHES EBULL INTO AG & BEYOND.  
BY CHAD ELMORE

The new Wiggins eBull is a zero-emission forklift with capacities ranging from 30,000 to 88,000 lb. Wiggins Lift Co. is a family-owned manufacturer in Southern California that has been building forklifts since the 1950s. It's made a name for itself by marketing and tailoring its machines to specific applications, especially marinas, and the company has continued that tradition with the eBull.

Depending on the market, the new forklift picks up a prefix as part of its model name — such as Marina eBull, Ag eBull or Yard eBull — the latter intended for port and terminal operators and manufacturers, logistics, warehousing, industrial and construction companies. The Ag eBull is designed to use attachments to pick 12 to 14 pallets, which are common in the California and Arizona produce industry, for example.

Regardless of application, the electric forklift uses fast charging lithium-ion batteries. Each has built-in onboard Level 1 and 2 charging and a DC quick charge option. Zero emission means they can be used inside warehouses with minimal impact.

"Wiggins is once again leading the charge in forklift innovation. The new eBull will significantly reduce greenhouse gas emissions and sound pollution while providing customers with the horsepower required to run their operations," said Mike Marzahl, president of XL Lifts. The California-based dealership specializes in zero- and low-

emissions forklifts and distributes the eBull west of the Mississippi River and in the Great Lakes region.

## GENESIS

Wiggins worked with Xos (formerly Thor Trucks) based in North Hollywood, Calif., to accelerate Wiggins' R&D effort and reduce development time. Xos unveiled a Class 8 heavy-duty battery-electric truck prototype in 2017 designed for short-haul and regional applications, and since that time has partnered with several companies to commercialize its battery technology.

"The genesis of the eBull is that Wiggins has been looking at having electric forklifts — big ones — more than 20 years," said Bruce Farber, Director of Engineering, Wiggins. "We originally started with lead acid but we couldn't cram enough power into them and they are half the density of steel, so they can't really replace the counterweight. We didn't see it being a viable product until lithium-

ion batteries came along, but the maturity of the batteries just were not there for this application until recently."

The development of battery technology to support electric passenger cars made it more promising to Wiggins' engineering team, but something still worried them.

"One flaw that concerned us about the lithium-ion batteries was if they got damaged, they could go into a cascade failure. That was very concerning to us because we know how people use our trucks," said Farber. "They abuse them horribly."

A couple of years ago, Wiggins set out to find a solution and "That's when we found a company in North Hollywood that had a very interesting improvement on the battery," said Farber. "If one cell fails, the adjacent cells will not so it stops the cascade failure problem. You could still have a defect, you could still have external damage, but it would be highly confined. That battery pack will be isolated from supplying energy and the vehicle could keep working safely with the other batteries."

## SYSTEM INTEGRATOR

Xos became a system integrator for Wiggins. "Anything on the high voltage side — the electric motors, inverters, the charging system — they took on the design of the high voltage circuitry, which really helped us get this to market quickly," said Farber.

The eBull is based on a diesel forklift frame; and most of the forklift's exterior remains unchanged. The 705v DC system powers an AC electric motor to feed power to the firm's proven drive axles and lift systems.

An eBull operator will notice that something is different because, "There's a lot more get up and go," said Farber, "and it's so quiet with no vibration. There's a gauge on the display that shows the state of charge,



The Ag eBull, photographed on its stand at World Ag Expo in February, is based on the diesel-powered Wiggins Bull.



<https://xliftsinc.com/>

[www.wigginslift.com](http://www.wigginslift.com)

The Wiggins Ag eBull is a lithium-ion battery-electric forklift designed for large produce handlers.



and it's the same as a fuel gauge on a diesel truck. It looks the same, behaves the same. For the most part, the truck takes care of itself. The operator does not have to learn anything new. He's just watching the state of charge and if he gets down to 5%, he better head to the charge station and take a break.

"We've modeled operational scenarios. One company operates eight hours a day; for them we expect this will go through an entire shift. But if they have four hours on and then an hour break and then another four hours of work, they can take advantage of opportunity charging and keep working longer." **NPP**

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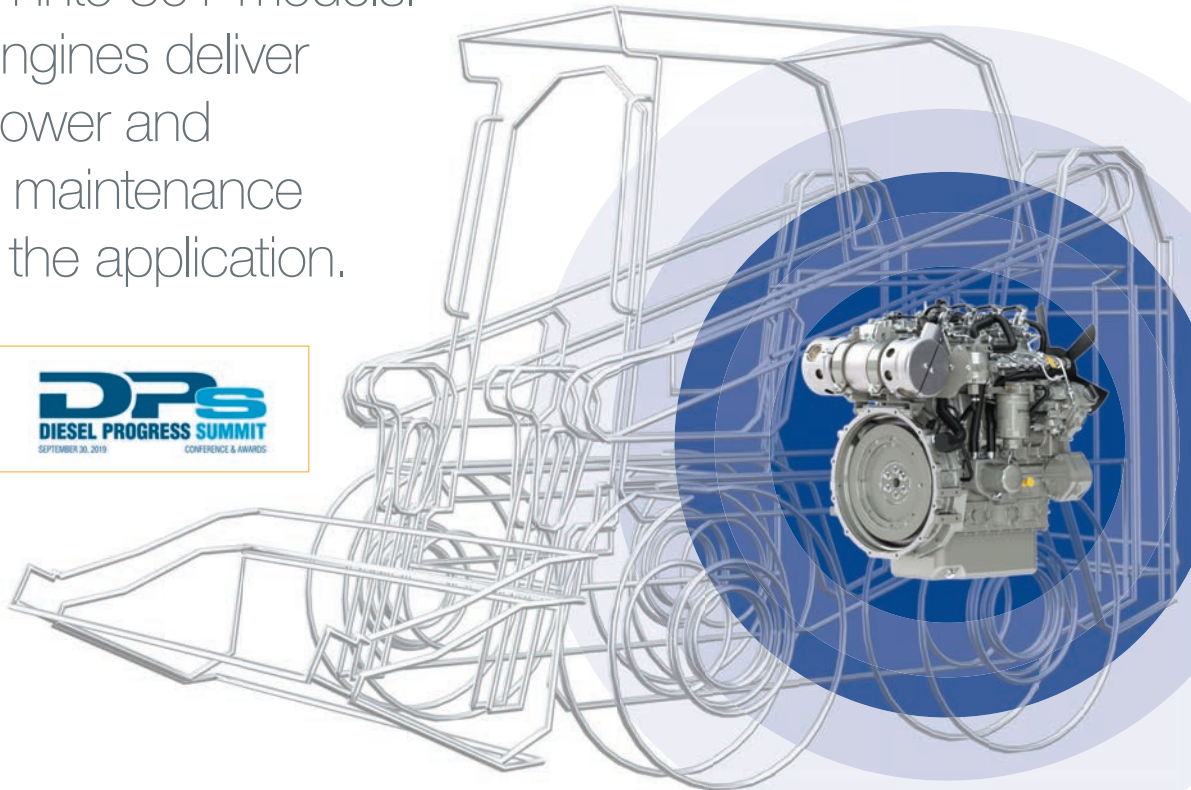
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# Lion adds all-electric Class 8 trucks

ALL-QUEBEC ALLIANCE MOVES LION FROM SCHOOL BUSES INTO TRUCKS. BY **MIKE OSENGA**

**A** Canadian company, Lion Electric Co., is introducing a range of all-electric commercial vehicles to the electrification marketplace. The difference, in Lion's case, is these are for the most part, designed from the ground up as all-electric vehicles.

Lion, Saint-Jérôme, Québec, actually started life as a manufacturer of diesel-powered school buses in 2008. In 2016, the company started producing all-electric school buses and in 2018 introduced the LionM, an all-electric midi/minibus designed specifically for paratransit and public transportation requirements. The LionM has a low floor and a ramp that deploys in 8 seconds.

"We eventually decided to go all-electric," said Lion's Patrick Gervais. "We think all-electric is the future and school buses were the ideal transportation mode to go electric first."

In April, Lion expanded and debuted the Lion8, an all-electric Class 8 truck and in June followed that up with an all-electric (including the automated collection hopper) Class 8

refuse truck.

The Lion8 will be commercialized this Fall and the first vehicle delivered to Société des Alcools du Québec (SAQ). SAQ is the provincial Crown corporation in Quebec responsible for the trade of alcoholic beverages within the province.

Lion said it benefitted from the Quebec Government's support (reportedly \$8.6 million) to develop the technology, with the Lion8 being a result of the 2013-2020 Climate Change Action Plan whose budget is derived from the Green Fund.

The truck is designed to be all-electric and has a range of up to 250 miles (400 km), Lion said. It has a 220 in. wheelbase and a 54,600 lb. GVWR.

Maximum power is 470 hp and torque is 2507 ft. lb. The powertrain continues the all-Quebec angle with a Sumo HD HV3500-9 phase motor and inverter provided by TM4 of Boucherville (now part of Dana Corp.). The front axle is a 14,600 lb. Hendrickson model with a tandem Dana 40,000 lb. rear axle. The suspension is Hendrickson and the air disc



Lion and Boivin Évolution have launched its initial Class 8 refuse truck with both the powertrain and automated collection hopper 100% electric.

brakes are from Bendix.

Battery capacity is listed as up to 480 kWh and the truck has Level 2 (J1772) and Level 3 (CCS-Combo) charging capabilities. Level 2 charging times are listed at 5 to 16 hours and Level 3 at 1.5 to 5 hours.

Lion has since announced that it has sold its first Lion8 vehicles in California to Constar Supply and C&S Wholesale Grocers Inc. Both companies are using the California Hybrid Truck and Bus Voucher Incentive Project (HVIP) to fund part of the upfront capital cost of the vehicle. Other funding sources will also contribute to the purchase of the vehicle, Lion said.

In June, Lion and Boivin Évolution (BEV), another Quebec-based company, showed its initial Class 8 refuse truck with both the powertrain and automated collection hopper being 100% electric. The new truck pairs the Lion8 chassis and the BEV all-electric automated side-loading hopper to collect household waste, recycling and organic material. All hopper and arm movements are powered by the vehicle's battery that drives electric motors for each function. **NPP**



With a powertrain from Dana's TM4 group, Canada's Lion Electric has introduced the Lion8, an all-electric Class 8 truck.

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# The electric waters of Scandinavia

The latest in an active e-ferry market in Scandinavia and Finland is the conversion of the Prosvik 1 ferry to a diesel-electric propulsion system.



IMAGE BY FRANZ AIRMAN

SCANDINAVIA & FINLAND ARE HOT E-MARKETS. BY MIKE OSENGA

**T**he marine markets in Scandinavia and Finland have been an interesting corner of the entire electrification story. Not as well publicized as the truck and bus efforts, the region is dotted with a lot of comparatively short haul trips, many served by government owned or operated ferry boats.

Combine that with governments in that part of the world seemingly being very interested in all things electric and you have an active, albeit mostly subsidized, market for diesel-electric or all-electric drive systems.

One of the more recent announcements finds Danfoss Editron continuing its recent activity in these marine markets with the announcement that been commissioned by the Suomenlahden Telakka Oy shipyard to provide a diesel-electrical drivetrain system for the Prosvik 1 ferry, which operates in Finland's Turku archipelago.

The entire diesel-powered propulsion of the ship will be retrofitted to a diesel-electrical drivetrain system with the expectation that it will improve its overall efficiency and reduce emissions. The four 274 kW generator sets are powered by 8.4 L marine SisuDiesel engines. Built in 1983, the 50m (164 ft.) long vessel can carry approximately 140 passengers and 30 vehicles.

Operated by Finferries, a Finnish state-owned ferry service provider, Prosvik 1 is one of two ferries operating

on the route between Nauvo and Korpoo., Danfoss Editron's diesel-electrical drivetrain system is designed to meet the space (compact) and weight (lightweight), requirements set by Finferries for Prosvik 1 which has a tonnage of 320t.

## INTELLIGENT MANAGEMENT

Atte Yrjola, sales support manager of Danfoss Editron, said: "Our direct current grid distribution and software-based approach allows for a much greater intelligent management of power distribution by enabling variable speed diesel generators. It also allows us to identify the optimal number of running engines needed in various weather conditions, ensuring the most efficient operation, offering additional fuel savings and reducing maintenance costs."

The Ellen, an all-electric ferry expected to traverse a 22-nautical mile crossing between the Danish islands of Ærø and Fynshav starts service this month. Just under 196 ft. long, the Ellen will travel at speeds between 13 and 15.5 knots.



The Prosvik 1 ferry will arrive at the Suomenlahden Telakka Oy shipyard in late August, before returning to operation by the end of November. As the ferry is one of only two operating on its route, a project schedule of just six months between kick-off and completion is being targeted.

Also in the news recently, this one in Denmark, is the Ellen, an all-electric ferry expected to traverse a 22-nautical mile crossing between the Danish islands of Ærø and Fynshav.

Operated by Ærø Kommune, the Ellen is just under 196 ft. (60m) long, and 42.6 ft. wide (13m) and will travel at speeds between 13 and 15.5 knots. It is capable of carrying 198 passengers in the summer, dropping to 147 during the winter. The ferry can also carry 31 cars or five trucks on its open deck.

The fully-electric drivetrain, also provided by Danfoss Editron, includes two 750 kW propulsion motors and two 250 kW thruster motors, both of which run off synchronous reluctance assisted permanent magnet technology and are controlled by DC/AC inverters.

As well as the electric drivetrain, Danfoss Editron also provided the vessel's power management system for the complete on-board automated power and load control. Additionally, the company delivered the onshore charging station and charging arm for the ferry's 4.3 MWh battery. As well as having a capacity of 4.3Mwh, it is also reportedly the first electric ferry to not have an emergency back-up generator on board, the company said. The Ellen is expected to enter service this month.

