Shop-Built E-Tractor Conversions

By Jim Ruen, Contributing Editor

Roy Bertalotto converted three lawn and garden tractors to electric power, all with the same e-components. He started with a Toro LX460 before moving the electronics to a Deere 214 and then a very rare Deere 316. An Ingersoll Case may be e-tractor number four. Converting a garden tractor made sense to him.

"Garden tractors don't get used every day," says Bertalotto. "With gas tractors, old fuel is a problem, as is ethanol."

With his e-tractor, he can plug it into the charger every few weeks and use it to mow for 45 min. straight or use it all day for intermittent work, like cutting firewood.

"I can start it and stop it, and the battery never drops below 50%," he says.

Bertalotto chose the Toro lawn tractor for his first effort due to its simplicity. He recognized that converting a vertical motor shaft machine would be easier, and his son-in-law had a Toro with a bad vertical motor.

The first step was to remove all internal combustion engine (ICE) components, including the lights, engine, wiring, throttle, gauges, etc. He retained the transmission and belt drive system and mounted a constant-speed motor, with the transmission controlling the ground speed.

"I could have used a DC motor controller and controlled ground speed by increasing or decreasing the speed of the motor," says Bertalotto. "But that would have added over $500 to the project for a controller and a throttle and added a bit more complexity."

He followed online advice and went with a Motenergy ME-1004. It weighed 32 lbs. and produced 13 hp at 3,300 rpm. He added a contactor, fuse and 48-volt DC batteries. The engine is capable of 200 amps continuous and 500 amps for a minute. It was 90% efficient with 6.4 kW continuous at 48 volts. He also added a 48/12-volt converter to power the lights and other 12-volt accessories.

Bertalotto considered building a lithium battery pack. Instead, he chose Duracell AGM 12-volt, 110Ah deep cycle batteries from Sam's Club, which cost $179 each. They were heavier, but weight was a good thing with the tractor.

Bertalotto lucked out on mounting the motor when he found a right-sized piece of scrap plate steel. He cut out a hole in the middle for the motor shaft and the pulley and drilled bolt holes with his milling machine. Two existing holes matched up with holes in the chassis.

"With the motor installed and the belts replaced, the next question was where to place the four 80-lb. batteries," says Bertalotto. "Most conversions I read about had them in the front of the tractor, but I was concerned about 320 lbs. of batteries over the front axle."

It took some cutting and welding, but he mounted two batteries under the seat and two over the motor in both cases, using angle iron support structures bolted to the frame.

He left a 2-in. gap between the batteries and a 1 1/2-in. gap above the motor for ventilation. Bertalotto also added a 129 cubic ft. per min. computer fan and a digital aquarium thermometer, which proved unneeded.

He mounted the 400-amp fuse, 400-amp contactor and the circuit board for the battery monitor on a piece of aluminum and bolted it to dash supports. The 12-volt fuse panel, 12-volt ground bus, the 500-amp shunt for the battery monitor, and the 48-volt DC to 12-volt DC converter were installed on the right side of the battery monitor. The shunt and ground bus were mounted on pvc plastic to isolate them from the chassis, and the 48-volt and 12-volt grounds had direct returns.

A battery monitor digital readout was cut into the dashboard. Where the ICE throttle had been, a piece of ABS plastic was molded to cover the hole. Toggle switches were installed for lights, the cooling fan and a potential third use. A dead man switch with an indicator light was installed to shut down all electricity in an emergency.

Bertalotto used the existing ignition switch to energize the motor by completing a low-current circuit to the contactor. The remote digital thermometer was installed in an existing space at the top of the dash. He fabricated a filler panel out of ABS to fit below the readout.

"I used 1/0 copper welding cable to wire the 48-volt stuff, crimped connectors on it and heat shrunk all of them," says Bertalotto. "I used marine grade, 12-ga. tinned copper wire for the 12-volt wiring."

He reports that the major costs for the conversion, which totaled $1,639, were the batteries at $716 and the motor at $607.

Bertalotto's primary concern was whether the differential and transmission could handle the instant torque with the 48-volt system. While it worked fine for a few days, it was clear it wouldn't last. The transmission became hard to get into gear, and the differential began making noise.

"I went to plan B and moved everything over to a Deere 214," says Bertalotto. "I found one for $100. It weighed about 300 lbs. more than the Toro, had a transaxle that looked like it came out of a Lincoln, and had huge axle shafts in reinforced axle housings. The steering mechanism looked like it came out of a trailer truck. Everything about it was massive. And since it was a 40-year-old Deere tractor, it was built like a tank."

Bertalotto decided to drop from a 48-volt system to 36 for a little less power. He found room for one battery just behind the grill. The second battery fit above the steering post and the variable drive where the original (smaller) battery had been. All that was needed was a single support piece of angle iron.

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Bertalotto discovered the frame rails on the 214 were 13.2 in. inside to inside, leaving room for one 13-in. wide AGM battery. He did have to cut down the back part of the chassis and weld in a couple of pieces of angle iron for support.

A bigger challenge was matching the motor's driveshaft with the 214s variator drive. Its variable-ratio pulleys change ground speed on the fly without changing tractor speed. The driveshaft needed to be horizontal versus the vertical shaft Toro.

Retaining the mounting plate from the Toro, Bertalotto welded in cross supports where the gas engine had sat. He machined slots into them to allow belt tension adjustment on the motor as needed.

The motor and mounting plate were set on their sides and bolted to the angle iron supports. For more support, the rear of the motor was put on a rubber block. Belt support pins were added to the plate to keep the drive belt away from the pulley when the tractor was in neutral.

Electrical components, except for the contactor, were again placed on a piece of aluminum and bolted to the side of the engine cowling with Z-brackets. The contactor was placed as close to the motor as possible.

"I used the old gas port on the rear body panel for a charging cable to the rear battery," says Bertalotto.

While the Deere 214 worked great, Bertalotto wanted to experiment with hydraulics. He knew that the Deere 300 series was a good fit.

"I wanted to find a 318 without a motor but with a working hydro drive system and dual brakes," says Bertalotto. "I also wanted two hydraulic spools for a four-way snowplow."

He didn't find a 318, but he did locate a 316G with a Kohler 341 engine. The 316 was only made for a year and is rare, yet Bertalotto paid only $250. To top off the deal, he sold the engine and many unnecessary parts with the conversion for $600.

"I decided to transfer all the electric components from the Deere 214 over to the 316," says Bertalotto.

While 36 volts was plenty on the 214, Bertalotto liked the option of going the full 48 volts on the 316. Because the 316 hydro was a direct drive instead of belts, the motor with its mounting plate was placed in its third position, this time with the shaft to the rear.

Connecting the motor and the hydro drive unit required building a coupler. He used a pulley that happened to fit the motor's keyed shaft and welded a piece of square tubing to it. At the other end, a flange was bolted to what Bertalotto calls a "quasi-universal joint that Deere uses."

He then transferred all the electronic components from the 214 to the 316. The first time he turned it on, everything worked, including putting it in forward, reverse and neutral. Everything ran nice and true with minimal vibration; however, it was much noisier than the 214.

His next step was to mount everything as he did on the 214. That included modifying the dashboard with a voltmeter and switches. The last step before replacing the body panels and seat base was positioning the four batteries.

"I knew I would have to fabricate a box for one battery to hang on the rear of the tractor," says Bertalotto. "I wanted the extra weight over the drive wheels."

To increase the rear weight, he placed a second battery over the rear differential with a rubber pad under it. At the front, he put a battery right behind the dashboard and directly over the motor, using an angle iron frame he fabricated.

Battery four was placed on the frame ahead of the motor, which required removing the original motor mounts.

"I really hadn't wanted to do that, in case I wanted to put it back to gas-powered," says Bertalotto. "I left space between the battery and the motor and mounted a fan over it in case the motor overheated. I've never had to use it."

With all the components and batteries installed and the tractor operating, his one frustration was the excess noise that seemed to come from the hydraulic pump. He determined it wasn't his coupler or the pump but the OEM universal.

"Deere used what is called a rag joint—basically, two discs with a small piece of fiberglass in between that's supposed to

Toro conversion batteries and motor.

Deere 214 battery and motor placement.