Agriculture Goes Electric

Electrification remains the most significant societal transition today, affecting virtually every industry as governments attempt to mitigate the effects of climate change and original equipment manufacturers (OEMs) and fleet operators adapt to changing markets and technologies.

But until recently, agriculture didn't experience these impacts as much as other sectors because legacy electric drive technologies and systems struggled to meet the industry's standard operational challenges. Power source availability (in particular), power output and density, charging times, charge duration, and other factors prevented an easy transition.

However, agriculture's electrification is already underway following multiple drivers and developments emerging in the past two decades. Government regulations, lithium battery and charging technology advancements, operational efficiency, greater telematics data availability, and more contribute substantially to electrification's progress.

What's Driving Agriculture's Electrification?

Ultimately, environmental and health regulations prove the most prominent driver behind agriculture's electrification. So, OEMs and fleet operators should only expect to see emissions requirements—such as the US's Tier IV, Euro 6, and China IV standards—become more demanding.

This is because governments worldwide largely failed to reach or maintain pace for their emissions reduction targets like those stated in climate pledges. As a result, they now feel more pressure than ever to mitigate the worst effects of climate change (e.g., increased weather-related events, water shortages).

With the electrification of on-road vehicles moving forward under its own momentum, the next target is (small and mid-sized) non-road mobile machinery (NRMM). This is currently demonstrated by bans on small off-road engines (SORES) for new outdoor power equipment as seen in California and elsewhere. And agriculture's machines won't be ignored with the industry contributing an estimated 33% of global greenhouse gasses (GHG) annually.

Moreover, government agencies like the Canadian Centre for Occupational Health and Safety (CCOHS) and the International Agency for Research on Cancer (IARC) recognize gas and diesel emissions' short- and long-term health hazards (e.g., respiratory issues, carcinogens found in diesel exhaust's particulate matter (PM)). Similarly, academic research has shown crop health and yields suffer from exposure to ICE emissions. These occupational, environmental, and public

health concerns will only lead to hastened implementation of those more rigorous requirements.

And given the current agriculture labor shortage with 40% of new industry jobs remaining open, increased sick days and workers looking for jobs in industries with fewer risks could be devastating for many farms. Workers may simply choose to only work on farms with electric equipment when possible.

Preparation Alongside Reduction

Yet this regulatory zeal also stems from governments' understanding that they must prepare for an electrified future.

Electric drive is certainly the leading alternative energy platform that will replace most internal combustion engines (ICE), but achieving that transition requires enormous investments. Just as innumerable gas and diesel stations didn't appear overnight, electrification necessitates accessible charging infrastructure, power grid resilience, and similar large-scale investments.

For example, the US made $24.5 billion available for EV charging, supply chain resiliency, and clean transportation and California's CORE program provides funding to accelerate companies' adoption of electric NRMM.

However, if government regulations and investment were electrification's only driver, innovations and adoption might stall. No technology facilitates societal shifts like electric drive without its own merits—namely, providing businesses with cost and efficiency advantages.

Benefits of Electrification

Electric drive offers substantial benefits to fleet operators over ICE NRMM, which will help achieve new efficiencies at both vehicle and business levels.

Regarding individual vehicles and machines, electric drive means vehicles deliver maximum torque at all times. This is especially important for agriculture since operators might struggle to keep gas or diesel engines in their powerbands with NRMM typically operating at lower RPMs and travel speeds. Combined with the lack of idling and warm-up periods, energy expenses never go to waste.

And at the business level, electric drive's telematics data and minimal maintenance requirements provides fleet managers with insight and capabilities not possible with ICEs. Fewer regular tasks like fluid changes and rubber replacement simplify maintenance. More

comprehensive and accessible telematics data enables more timely service scheduling and better resource allocation to prevent downtime and costly service calls out to the field.

Electric drive simply provides too many benefits across more efficient energy usage, lower maintenance costs, less downtime, and better operational planning for regulations to be the *sole* driver.

Still, electrifying agricultural fleets helps 'future-proof' operations. Farms will meet current and coming regulatory requirements (e.g., 'zero emissions'), transition to the next dominant energy platform early, and open more possibilities for autonomous machines and equipment to handle simple tasks—as seen in industries like materials handling. Future pressures of emissions compliance, fuel price fluctuations, potential labor shortages, and more can be avoided entirely.

Battery and Charger Technology Advancements

The benefits explored above only became possible recently due to battery, charger, and similar technology innovations. Of those, the introduction, cost reduction, and availability of lithium batteries has made the biggest impacts. For example, fast-charging wasn't possible before lithium batteries, which has proved one of the biggest hurdles in electrifying agriculture's day-long usage of machines out in the field.

Today's lithium batteries provide the necessary power output and density, durability, and longevity to help electric drive platforms reach performance levels farmers need. But a battery is only as good as the charger that keeps it operating optimally.

More powerful chargers replenish batteries more rapidly, although that's far from the only advancement. Chargers can now be mounted on-board to reduce storage requirements and charging hassles (e.g., gathering cables) while enabling opportunity charging—potentially from portable power sources or solar installations.

The most important charger advancement, however, has likely been the introduction of far more sophisticated charging systems that regulate battery charging to ensure maximum longevity and performance while providing more comprehensive telematics data. Voltage, usage consistency, poor charging practices, equipment failure flags, and more information can be easily monitored to preemptively address situations.

With today's battery and charging capability and insight, fleet managers can better optimize operations and resource allocations based on vehicle and energy usage than they've ever been able to with ICE platforms.

Agriculture's Electrified Future

Regulations and health concerns may remain the most prominent driver of agriculture's electrification, but the transition wouldn't be possible at all without investment and the right technology advancements achieving necessary performance levels. And, admittedly, before the last two decades of innovation, agricultural machines and equipment largely *couldn't* be electrified.

But that's no longer true.

The benefits of more efficient energy usage, lower operational costs, much less demanding maintenance, and data-based insight ensure that electric agricultural equipment makes an immediate impact on any farm. And although that makes electric drive competitive with ICEs today, forthcoming regulations (and higher sticker prices from more complex emissions technologies), future innovation, and broader societal adoption will only create a large gap in electrification's favor.

The last hurdles being solved now involve outfitting farms with sufficient charging infrastructure and developing batteries and electric drive systems capable of powering the largest agricultural machines. But with these technologies seeming to progress daily and the ability to better leverage data, the electrification possibilities—like autonomous NRMM—become endless.

Sources:

Our World in Data. *How much of global greenhouse gas emissions come from food?* https://ourworldindata.org/greenhouse-gas-emissions-food

Canadian Centre for Occupational Health and Safety. *Don't Let Exposure to Diesel Exhaust Leave You Breathless*. https://www.ccohs.ca/newsletters/hsreport/issues/2018/09/ezine.html

International Agency for Research on Cancer. *IARC: Diesel Engine Exhaust Carcinogenic*. https://www.iarc.who.int/wp-content/uploads/2018/07/pr213_E.pdf

Environmental Geochemistry and Health. *Effect of Diesel Fuel on Growth of Selected Plant Species.* https://www.researchgate.net/publication/226142230_Effect_of_Diesel_Fuel_on_Growth_of_Selected_Plant_Species

Successful Farming. *Supply chain, labor shortages still limitations to manufacturers in 2023.* https://www.agriculture.com/machinery/supply-chain-labor-shortages-still-limitations-to-manufacturers-in-2023

The White House. *FACT SHEET: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers.* https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers/

California CORE. *California CORE.* https://californiacore.org/