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# Battery power moves up a gear

Every year we take a look at the latest developments in battery power for equipment such as aerial lifts, telehandlers and cranes. This has usually focused on aerial work platforms, but in the past year telehandler and crane manufacturers have started spending an increasing amount of their development budgets and time on battery power.

Batteries have powered the majority of self-propelled aerial work platforms since the industry's earliest days, mostly slab electric scissors, small trailer lifts and industrial boom lifts. For most of that time battery developments in the sector have been limited. In fact, in this feature a few years back the manager of a major battery manufacturer was adamant that there was zero chance of lithium or any other new battery technology replacing lead acid batteries on boom or scissor lifts in our lifetime. The traditional lead acid battery is highly efficient, relatively cheap and 98 percent recyclable without much effort. All of which remains true, however that ignores the fact that they require regular care and maintenance, emit flammable gasses when recharging and can spill etc... Lithium power did arrive and is increasingly gaining traction, it began 12 years ago with the launch of Hinowa's first lithium powered spider lift. Most spider lift manufacturers now offer a lithium option, and they are becoming increasingly popular as end users discover the benefits of quiet fume free operation, without sacrificing run times.

## Lithium and AGM growth

More recently lithium batteries have become available that can replace the standard six volt lead acid batteries found on most aerial lifts, and are seeing increased take up, mostly by those who wish to avoid the cost of maintaining traditional batteries as well as faster recharge times. However, the latest generation of AGM sealed batteries are proving even more popular, with some manufacturers installing them as original equipment. They offer the maintenance free and improved density advantages of lithium, but at a more attractive price.



U.S. Battery's new AGM battery.



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C&A

batteries

Lead acid batteries do require regular maintenance



Discover has entered the market with a line of sealed battery alternatives.

One leading powered access battery supplier - U.S. Battery - launched an improved line of AGM Deep Cycle batteries earlier this month, which it claims offer improved cycling performance and longevity. The benefits derive from the use of thicker positive alloy grids, high density positive active material, and advanced glass mat separators, all of which helps maintain the battery cell structure during deep cycling, while limiting acid stratification, and inhibiting internal shorts. The new batteries also feature a carbon enhanced negative active material that improves charge acceptance and cycling performance, while being more resistant to vibration in tough applications.

At the end of last year Discover Battery entered the European aerial lift market with a range of sealed deep cycle Dry Cell, Gel and AES Lithium batteries. It cites significantly reduced maintenance, higher operating voltages, longer runtimes, and the ability to withstand deep discharges as the key advantages of these new batteries, all of which is appealing to a growing number of fleet owners and end users.

However perhaps the most significant indication that the pace of change is ramping up is the number of new larger all electric products coming onto the market. In the last issue we covered all electric Rough Terrain scissiors and before

that the strong growth in electric boom lifts up to 70ft. This year has also seen increased interest in all electric telehandlers, led by Faresin and Merlo, with JCB ready to join the fray along with Manitou. And now the final lifting equipment bastion looks set to fall, as crane manufacturers begin to seriously consider the practicalities of electric power. The leading manufacturers will surely be aware at how the shift towards battery powered cars is completely changing the market dynamics, with Tesla having built more than half a million cars last year and set to ship a million in 2021, barely 10 years after it shipped its first car! The company never even existed until 2003. Some Chinese manufacturers probably see an opportunity to do something similar in the crane market, and steal a march on the three largest western crane manufacturers? They have the support of a government that is investing heavily to help manufacturers develop emission free vehicles or equipment, to reduce pollution as much as meet its target of becoming carbon neutral before 2060.

So, for the first time in the history of this feature we are taking an in depth look at battery developments in the mobile crane market.

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# Green shoots

While the cost of batteries, as well as real world challenges, currently precludes their wider use for most heavy road transport, a range of mobile crane manufacturers are offering electric power for working on city centre job sites or even local or site travel. Will North reports.

Earlier this year Liebherr Nenzing made an announcement that promises to reshape the crawler crane industry: two of its crawler crane models will be offered with battery packs allowing them to operate on site under electric power. The new 'Unplugged' machines can operate on battery power and even travel short distances on site. Once in a lift position they can also be connected to an AC mains outlet.

A month later, an arguably bigger announcement came from an unexpected source: PVE, which had previously focused on the manufacture of foundation rigs before selling this business, said it will now introduce a line of fully battery powered cranes able to work a full shift without needing to be recharged.

While all electric mobile cranes are still relatively rare, these new cranes are not the first non-industrial mobile cranes to offer clean, quiet power. Spierings finally began shipping its three axle tower-type All Terrain, the City Boy, last March with its hybrid powertrain. The battery pack is big enough for up to 20 miles of road travel, allowing owners to travel and

work within city centre Ultra-Low Emission Zones. They can simply travel to the edge of the zone under diesel power - charging the battery as they go - and then switch over to electric power as they enter the restricted area.

The company has also introduced the e-Lift option on its four and six axle cranes. While this does not allow them to be fully battery powered, it does enable the cranes to be plugged into a normal AC outlet, with the battery boosting the mains power when high draw functions are operated.

Demag has also been looking at the growing demand for electric powered machines, with its modular E-Pack which can be mounted on its AC45 City crane, to allow plug in crane operation on site. While it largely targets industrial movers and riggers that use this type of crane indoors, it has also announced that it will offer the E-Pack on its new AC 80-4 All Terrain.

Liebherr Biberach has for many years offered plug in electric power for crane operations on its MK range of mobile tower cranes. Initially, this required a 63 Amp power outlet, while this is normal for larger



Kynningsrud puts the first Liebherr Unplugged crane to work



Hiab's ePTO makes it easy to mount its cranes on chassis running on a range of power sources. Its rechargeable battery allows it to work silently and emissions free.



The latest version of Zoomlion's ZTC250N-EV pure electric 25t truck crane

## Pure electric truck crane

Last May, Chinese manufacturer Zoomlion launched what it claimed was the world's first pure electric powered truck crane with its 25 tonne ZTC250N-EV. The three axle crane, by far the most popular type of crane type in the country, was based on the manufacturer's standard diesel model, but the engine is replaced with a high density lithium iron phosphate battery pack and electric motors. It has now released a new version with no superstructure cab, with the space used to house a massive battery pack that is said to offer a travel range of 140

miles/230kmat a top speed of 90kph/56mph with 50 percent gradeability. Once on site it must be plugged in and can apparently be recharged to 80 percent in an hour while also working. The crane is also equipped with self-drive on roads that are suitably equipped, and unmanned operation, with an app style remote controller. The load can be laser guided with the ability to lock on to the placement position, while a built in anti-sway device helps stop the load from swinging erratically.



construction sites in many parts of Europe, it can be a problem on smaller sites or when working on existing buildings. More recently, it has optimised the crane to allow it to work from 32 Amp outlets.

Loader crane manufacturer Hiab offers the ePTO (electric Power Take Off). As with Demag's E-Pack, the module sits between the truck's diesel power source and the crane's hydraulics, allowing the crane to work on battery electric power when on site, while often mounted on a chassis that uses the cleanest fuels currently available.

### Why go electric?

In 1966, after building a following as an acoustic folk singer, Bob Dylan walked onto stage for the second half of his show at the Manchester Free Trade Hall, carrying an electric guitar. As he and his band started playing, the audience erupted: one enraged folkie even shouted "Judas!" at him. The moment must have felt like it carried considerable cost for Dylan, and his band. But it opened a new direction in Dylan's career, and arguably changed the music scene forever, melding the lyrical complexity of folk singer songwriters with the emotional power and sheer heft of amplified electric rock and blues.

Those making the move to electric cranes may also, like Dylan, face naysayers. The equipment will cost more and add weight to the set up.

Ultimately, Dylan's move was based on his own tastes, and perhaps a sense of the commercial opportunity.

No one, other than perhaps a few crazed and joyless puritans, was looking to ban the acoustic guitar.

That is not the case for the crane industry. Bans on the use of diesel equipment already exist. In a few streets in the City of London - the 'Square Mile' that forms the financial district - two experimental 'Zero Emissions Zones' or ZEZs have been implemented. The Mayor of London, Sadiq Khan, has plans to implement these zones throughout the wider city by 2025. He is not alone. Some 25 cities across Europe, have announced similar restrictions, including some of the most competitive markets for the rental industry. And they are all a sign of things to come.

There is a pressing need here. We are all aware of the fact that human action is changing our climate for the worse. As well as threatening the survival of future generations, pollution is already killing people. Late last year a London coroner ruled that nine year old Ella Kissi-Debrah's death, and the suffering she endured when repeatedly hospitalised by asthma attacks, had been caused, in part, by nitrogen



*Spierings' eDrive on its City Boy allows it to drive into city centres where emissions restrictions would otherwise be an obstacle*



*Tadano-Demag's E-Pack allows a standard AC-45 City to work on electric power when needed*

dioxide and particulate emissions from the road near her home. Studies from King's College London show that up to 36,000 deaths a year in the UK may be caused by emissions. Quite simply, owners of an all diesel fleet may find themselves having to increasingly focus on work outside of city centres. Eventually there will be no option but to go fully emissions free. When Dylan made his move to electric, noise was a key benefit. Folk gigs would typically take place in the backroom of pubs and bars, with a couple of hundred fans listening in near silent reverence to his acoustic guitar. With amplification, he could bring his playing to much larger audiences.

When it comes to lifting equipment however, the reverse is the case, with electrification reducing noise opening up work in areas where noise is an issue. As we will see, it's a particular benefit with loader cranes, allowing for early morning or late night deliveries or collections in urban areas, where it might otherwise be banned. At the same time operators and rigging crews are better able to communicate when all is quiet.

### Current state

As we have seen, the current offerings split into two main types: those that can both travel emissions free and operate on site without plugging in, and cranes like the Demag with E-Pack, Liebherr MK,



*The battery pack motor and cable installation on Liebherr's Unplugged machines*



Liebherr's  
LR 1250-1  
Unplugged

or Spierings eLift that can work emission free when plugged in, but still need diesel power to get to site.

### Perfectly balanced?

Liebherr has a reputation for using cutting edge technology to optimise its cranes to suit customer requirements. Arguably this is what has made it one of the world's most successful crane manufacturers. It was this balancing of technical possibilities with user needs that lead to the concept behind the Unplugged cranes. The batteries serve two purposes. They allow the cranes to travel up to 600 metres or so on site without trailing a large cable, but perhaps more importantly, they act as a buffer, supporting the available AC power supply for the heavier lifts or maximum speeds. This also allows the crane to operate without compromise on 32, 63 or 125 Amp power supplies or for up to four hours of typical use on the battery pack. Recharging drained batteries takes between 2.25 and 4.5 hours depending on the supply, but when operating plugged in the batteries are continually being topped up.

Dietmar Hämmerle, product manager, crawler cranes, explains: "Our analyses show that the travel function plays a subordinate role for crawler cranes working in urban areas, the hoist and slew functions are the most used. This means that the crane usually works plugged in. Typical unplugged jobs are those where the crane changes its position and moves, for example, to the opposite side of the building or from the erection site to its assigned work site."

Batteries currently have a lower energy density than diesel and as such add weight to the machine. This can actually have some counterweight advantages. Hämmerle confirms that the Unplugged versions do have a slightly improved the lifting capacity load curve.

The two new cranes are just the start for Liebherr Nenzing, which builds lattice crawlers up to 300 tonnes. Hämmerle says: "When it came to the question of which size of crane to be our first with a zero emission option, we decided on the mid-range of our programme: the

# Anything ELSE TO lift?

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200 tonne LR 1200.1 and 250 tonne LR 1250.1. This is a suitable size for many of our customers, but not for all. So, we were automatically confronted with the question of which models we would do next. We are focusing on the 130 and 160 tonne range, with which we will come onto the market starting at the end of the year. The technology concept used is also suitable for larger cranes." The conversions are relative straightforward, in that around 90 percent of the Unplugged models remain unchanged from the diesel versions. Taking a simplistic approach, the diesel is replaced with a battery pack and a big electric motor to drive the same hydraulic set up – so not the most efficient power train. Ideally the hydraulic hoist, slew and track drive motors would all be replaced with the latest AC electric motors, thus eliminating the vast majority of the hydraulics and substantially boosting efficiency.

### Going all-in

PVE took a different approach on the cranes its new company, PV-E Crane BV are building. They will be fully battery powered and include a quick change battery pack rather than relying on the whole crane having to remain plugged in. This means that the crane can work a full shift with a completely self-contained electric power source.

The lead customer is VolkerWessels Materieel en Logistiek, the in-house equipment supplier for the VolkerWessels construction group, which also rents its equipment out to third parties. Managing director Dick van de Laar says: "The biggest crawler crane we have today is 120 tonnes. We see a bigger demand coming up for the 160 to 180 tonne capacity. So, we looked into the Tier V diesel cranes and then we had a meeting with PVE chief executive Joost Bömer who pointed out that they were working on an electric version. That gave us the opportunity to skip Tier V, the most efficient diesel version, and go directly to electric cranes, so we made a deal."

A key driver for the Dutch contractor are the requirements of Natura 2000 sites which are scattered across Europe, with a noticeable density in the Netherlands. The EU encourages landowners on the sites to protect local wildlife and migrating birds.

Owning electric cranes will help VolkerWessels to obtain work on these sites.

PVE has historically built crawler foundation type crawler cranes, but sold the business to a private equity investor, while keeping its rental operation. Bömer says: "Starting in 2020, some contractors were asking, 'Is there a way we can get an electric crane?' And of course, there was nothing in the market at that time. We knew everything about crawler cranes, but nothing about electrification. So, we teamed up with a local Dutch company that specialises in automotive electrification. We are adapting their technology for our cranes, in order to put an electric crane on the market.

"Our philosophy is you need to be able to work at least eight hours on a charge. The batteries are designed in such a way that if you want to work a double shift, you can easily take out the batteries and replace them with a full battery pack."

Bömer notes that the most popular crawler crane sizes do not require a great deal of power. "If you look in the range from 80 to 250 tonnes, in any manufacturer's range, all those engines are around 210 kilowatts: so not a lot of power and theoretically easy to electrify." The first cranes in the range have the battery pack and electric motor powering a hydraulic pump, which powers the crane. But, Bömer says, for the next step, perhaps in the next two to three years, he will build



PVE's all electric crane



(L-R) Dick van de Laar of VolkerWessels with Joost Bömer of PVE and Rob van den Boogaard VolkerWessels

a fully electric crane. As well as the hydraulics used in lifting and travel, cranes need power for a range of other functions. PVE has focussed on minimising the requirements here as much as possible. So, the hydraulics are cooled with up to four fans, but each only works when needed. The cab heating has also been redesigned, in order to minimise power consumption. PVE rates the battery packs for the

cranes at 260kW, but in fact, the batteries hold 300kW of power, giving an additional headroom to ensure the crane can work all day. This is particularly important in winter, when low temperatures reduce battery capacity.

### A choice to make

Potential customers will, of course, be swayed by brand familiarity and confidence when making their



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purchases. Some will have an existing relationship with Liebherr, or just be more comfortable testing new technology from one of the best known names in the business. Others will value the ability to work on sites without being tethered to a cable. Some, perhaps, will be inspired by the ambition of PVE's plans.

Eliminating the need to manage diesel supplies brings its own efficiencies. But Volker Stevins' van de Laar sees the presence of a high power line running across the job site as a downside to Liebherr's approach. Also, both he and Bömer are sceptical about having to transfer power from the chassis to superstructure via the swivel's slip ring connections. On the PVE, the battery pack is mounted on the superstructure with only a hydraulic connection down to the tracks.

Hämmerle dismisses these concerns. Acknowledging that a cable connection to the superstructure would make slewing the crane impractical, he sees no issue with the technology Liebherr uses. "The slip ring body technology is fully developed, and we have been using it in many of our products for decades. From our point of view, as well as that of our customers, a slip ring collector is an absolute must."

### Green towers

The technology differences seen with the new electric crawler cranes are mirrored in the mobile tower crane market, where Liebherr faces another Dutch rival: Spierings. The Spierings City Boy can top up its substantial battery pack while driving under diesel power. Once on site it can operate on battery power, but ideally will be plugged in



*With Spierings' eLift cranes, operators just plug to the available socket to work emissions and noise free*



to a local power source. The battery pack still acts as a buffer, ensuring that there is always enough power available to lift at full speed and capacity, even with a 32 Amp domestic connection. Spierings uses a similar solution for its larger new cranes, the SK597-AT4 eLift and SK1265-AT6 eLift, which both allow for electric powered lifting, but not electric travel.

Liebherr has so far not attempted electric travel due to the constraints of battery technology. Its MK cranes are built at Liebherr's Biberach factory, with the chassis coming from the group's mobile crane plant at Ehingen.

Product manager Wolfgang Schlaucher says: "Our four and five axle cranes are equipped with the latest engines and so we fulfil, or sometimes exceed, the local emission requirements. We

decided not to offer electric crane travel as we do not think that it is economically or functionally practical yet on four and five axle cranes."

Liebherr's all electric lifting systems allows the cranes to operate directly on lower power outlets without the need to use a battery booster. As Schlaucher says: "We go directly with one energy, all the way to the hook." On many, if not most, sites in European countries like Germany, a 63 Amp power is available early in the construction process he says. But some sites only offer a 32 Amp outlet. That could mean drop offs in performance, or, worse, overloading the site's power supply. However, in these situations, Liebherr's system avoids this by directing power to each crane function at a time, rather than for multiple functions simultaneously.

Liebherr has also optimised the energy further by installing LED work lights in place of halogen. But the hoist motors draw the most power, which can, according to Schlaucher, result in slower speeds and acceleration on a 32 Amp outlet. Where no sensible power outlet is available the crane can be powered by a PTO generator on the carrier engine. However, the manufacturer has instead added a small 55kw diesel generator which is a lot more efficient.

### Green as you need

Small city type All Terrains, as their name suggests, were initially designed for work around congested urban areas, but another key application is installing/removing industrial machinery. It was this work, says Demag R&D director Ascan Klein, that led to the development of the E-Pack for the AC 45 City. "We wanted a zero emissions option as they are often used for indoor applications and nobody wants to work among exhaust emissions, while sophisticated cleaning systems, or long hoses to take the exhaust outside are not ideal."

The system is designed around typical in-plant power supplies.



*By plugging in its MK 88 Plus, Krandienst Kunze was able to work without noise for an extra two hours a day in the historic centre of Dresden*





Tadano Demag's E-Pack is now also available on the new AC 80-4



Tadano Demag's E-Pack

While the crane's engine may deliver 400 horsepower, it is not required for lifting work. The 400 volt/63 Amp power typically available in factories is enough to supply the 35Kw/45hp required to operate the crane superstructure. The E-Pack can be mounted on the back of the crane. Initially it was transported separately and installed on site, but Demag's latest iteration can be fitted at the depot and travel on board. Once the crane is in position and ready to work, it is plugged into the electric power source. Electric power passes through frequency inverters to an electric motor, driving a hydraulic pump, with hydraulic connectors tapping into the crane's circuits. For operators using the latest version of the E-Pack, switching between diesel and electric on site is just a question of plugging in and tapping the touch screen.

For most operations, the crane offers the same performance as running on diesel, with only a slight decline in performance when hoisting at maximum capacity but

lifting heavy loads in confined spaces does not require maximum speed. In fact, millimetre precision is far more important on these jobs than speed. The system will also work from a 32 Amp power outlet but with a sharper speed drop on the heaviest lifts.

While the AC45 City E-Pack is focussed on such applications, the recently launched four axle AC80-4 is more construction orientated. The E-Pack is intended to allow it to work on city centre sites, where emission restrictions are in place. An increasing number of locations in the Netherlands and Switzerland already rule against diesel idling when in stand-by mode. More specific restrictions can apply when working near a hospital, say, or in a residential area, and do not just apply to emissions, but also noise. A crane like the AC80-4 often operates intermittently throughout the day. The E-Pack means it is ready to lift when needed, without the constant need to start up and stop the diesel engine.

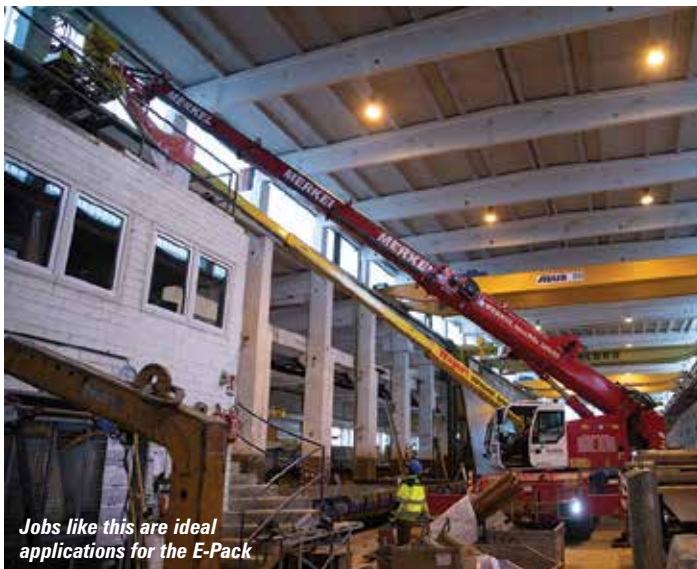
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*Jobs like this are ideal applications for the E-Pack*

Noting the continual evolution of propulsion technology and the importance of residual value to crane buyers, Klein says that a modular approach like E-Pack allows customers to upgrade their machine with new technology, without needing any major modifications of the crane.

### Tailor made power

For loader crane manufacturers like Hiab, it is increasingly important to provide customers with flexible ways of working. "The ePTO provides customers with a wider range of opportunities," says Hans Ohlsson, Hiab's director of global product management. "Customers in Paris, London, and Stockholm are already using ePTO cranes on standard diesel trucks for overnight deliveries, as while they aren't restricted from driving at night, they do face noise restrictions when it

comes to working at these times. With the ePTO, you can work silently this is currently the biggest advantage."

The power requirements for lifting are not that high. Hiab offers the system in two versions, 20 and 40kW. On the latter the crane can work for around four hours between recharges. For a delivery or waste collection company, topping up the battery while driving between stops ensures that there is always plenty of power. Builders' merchants for example find that even the 20kW version is sufficient for a full day's work.

Hiab is also working on a new version, which will allow it to recharge while working plugged in. As knuckleboom cranes become more widely used for mobile crane work, this will open up yet more potential. The biggest cost on the

system are the batteries which also add weight and soak up available payload. So, another development on the drawing board, is an even smaller 13kW version. At the same time rapidly developing battery technology is also reducing weight and cost.

When it comes to the chassis the technology is still not ready for wider use.

Hiab's director for key accounts, John Bailey sees the decisions customers are making. He says that a fully electric truck can be triple the price of a standard diesel. This is clearly a financial impossibility for builders' merchants, most of whom do not charge for deliveries. While vehicle manufacturers are pushing hard to deliver cost effective, alternatives for their vehicles, it seems unlikely that there will be an easy answer to this problem any time soon: certainly, London's 2025 deadline for green commercial vehicles seems like a very tight deadline.

But Hiab's customers have found ways around this problem. One early adopter of ePTO was UK timber merchant Lawsons. It needed a clean, quiet solution for night time deliveries while meeting London's increasingly restrictive emissions rules. It is combining the ePTO with a compressed natural gas (CNG) chassis. With a CNG fuelling station within handy reach in South London, this was a relatively easy choice. But elsewhere the move to CNG is often more of a challenge. Bailey also points out the other advantage



*Hiab's ePTO can run from batteries charged by the chassis or from the grid*

to the ePTO cranes – noise. While obviously a concern to those living near a delivery site, it also has an impact for those working with the crane. Extensive studies, going back well into the 1980s, demonstrate a strong link between noise and stress, making them more likely to be distracted and to miss verbal communications from others on site, making accidents more likely. Bailey says: "The feedback we're getting from operators is that they feel more relaxed and more confident. If there isn't as much noise around them, they can hear something coming up behind them, they can hear a bike or a car. So, there's an advantage from a health and safety point of view. And every driver I have spoken to that has used it, says it's less stressful."

### Wider responsibilities

Across the mobile crane sector, manufacturers are making progress towards adopting cleaner technologies. Crane owners are increasingly exploring greener, quieter ways to work, while respecting the environment, their employees, and the people living and working around the sites where they operate.

The crane industry is, however, a relative niche sector: even loader cranes, are only used on around a third of delivery vehicles. Politicians are right to set deadlines for ending emissions. But their role can't end there. Banning diesel engines without cost effective widely available alternatives might cut emissions, but it will also cause the whole economy to seize up. Delivering a green construction industry without causing major disruption will need public sector investment in innovation, a willingness to pay the going rate and a careful balancing of taxation and subsidisation of vehicle purchases. When that happens, the crane industry will be more than ready to play its part.



*Robin Feller of Pink Cargo says that Hiab's ePTO allows him to talk to customers, without the noise of a diesel*



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