

Hybrid machines - the future or an interim solution?

When it comes to hybrid aerial work platforms there is still some confusion as to what exactly is meant. Most take the view that a hybrid is neither a diesel nor a battery powered machine. However in some cases it could be argued that it is in fact both, combining an electric and internal combustion engine in the same vehicle. But is a hybrid just a temporary solution as we move towards all electric or maybe hydrogen power?

Dictionary definitions of hybrid include:

- "The offspring of two plants or animals of different species or varieties, such as a mule."
- "A thing made by combining two different elements – jungle music is a hybrid of reggae and house music."
- And perhaps more relevantly - "A car with a petrol engine and an electric motor, each of which can propel it."

The concept of two separate power sources has been around for many

years, especially in the aerial work platform market. In North America it tended to be 'Dual Fuel' - gasoline/petrol and propane - the idea being that you used fuel outside and switched to propane when working indoors, the propane also offered a backup when the fuel tank ran dry. In Europe neither petrol nor propane were welcome on construction sites so Bi-Energy machines were invented.

Whose idea was the Bi-Energy?

It is hard to pin down exactly where the Bi-Energy concept originated



An early Niftylift Bi-Energy boom lift



although a few candidates jump out including Economy Engineering with a generator on its Wildcat scissor lifts, an idea copied by Instant Zip Up in the UK for the UpRight XL24 scissor. The Bi-Energy concept is however more associated with Niftylift on its HR10/HR12 boom lifts. The company's first electric powered boom lifts suffered from poor battery life, especially when used outside where longer drive distances are common. The early machines also had very little 'grunt' and struggled to cope with poor ground conditions, which also soaked up battery power. Niftylift's Bi-Energy design solved both issues. The solution was to take a diesel or petrol powered unit and equip it with a secondary electric power train - batteries, motor and pump. The resulting product also perfectly suited the budding UK access rental industry, with companies looking for machines which covered a wide range of applications. The Niftylift HR12BE could be rented to contractors on rough sites but were equally at home working quietly and emission free inside. So no

matter what type of 33ft boom lift a customer requested the one in the yard was always the right one. Few things were more frustrating than receiving an order for an electric boom lift, when all you had sitting was a diesel! Or vice versa. There was also the added advantage that a customer could keep the same machine as the work progressed from steel erecting outside to the internal fit out. The concept became so popular that others followed including Genie and later UpRight and Manitou.

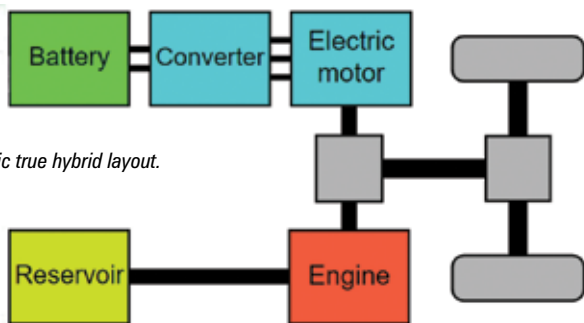
When it comes to the scissor lifts mentioned it was a different situation. All small scissor lifts were built in the USA - mainly for the North American market which showed little interest in a Bi-Energy concept. American contractors typically have far more machines on site limiting the need to drive any great distance or for tradesmen to share a machine. So battery related issues were less of a factor, and if in doubt, propane power was perfectly acceptable for internal use.

European dealers solved the problem themselves, mounting a small generator pack on the back of the chassis which could recharge the battery pack. These were eventually adopted by manufacturers.

A weakness of the concept was the need for a line contactor to stop the charging process whenever the machine was operated. This was OK when adjusting the height occasionally or moving a metre or so along the work face, but the



The UpRight XL24 with Gas Pack option



Basic true hybrid layout.

bizarre situation would arise where an operator would start the engine to drive across the yard "to maintain battery charge" but nothing was actually happening as long as the controller was activated! The engine was running, but the battery pack was not benefiting. Later products eliminated the need for line contactors, while larger generators supplied enough power to keep pace with consumption. But by then the market had moved on.

Real Bi-Energy?

These two different solutions led to the term 'Real Bi-Energy' being coined - usually for the Niftylift solution. The expression still lingers, with talk of a 'Real' or 'True hybrids' while the two bi-energy solutions were not comparable with each other, that is not the case for the hybrid concepts used on the latest boom lifts.

What is a true hybrid?

From an impartial standpoint a true hybrid is a machine that has all the performance of a battery electric platform, but also operates continually on diesel power while offering the same gradeability and speeds the diesel model. If these two measures are met, then surely they are true hybrids?

One way to achieve this is to take an internal combustion machine, equip it with a smaller more fuel efficient engine sufficient for most two wheel drive applications, and add a full size electric motor/pump power unit and battery pack to the drive train. Then design the operating system so that the two power sources can combine when peak power is required, with the electric driven pump adding its hydraulic power to that of the diesel driven pump. The resulting power boost deals with steep

gradients and boggy ground etc... at the same time the diesel can be equipped with a generator to top up and recharge the batteries remotely. Clearly a true hybrid system with all the benefits.

An alternative solution is to take a modern, all electric machine, complete with direct electric wheel drive and equip it with a small diesel engine and generator with sufficient output to keep the batteries topped up during continuous full power operation. This does of course require a battery pack that can be 'opportunity charged' while the machine is being operated. This surely is also a true hybrid machine? There are a few different variations between these two solutions, but in essence most machines fall into one camp or the other.

Niftylift's Gen2 Hybrid

Niftylift was also one of the first manufacturers to launch a hybrid boom lift when it introduced its first model in 2007. Since then it has refined the concept and expanded the range to include the 43ft HR15, 50ft HR17, 63ft HR21 and 86ft HR28. Last month it announced the latest generation which includes a Stage V diesel engine. It has named it 'Gen2 Hybrid' when it is in fact the company's third generation hybrid system.

As with earlier versions the machines can be used as full electric booms, or an uncompromising diesel with the electric motor providing an automatic power boost to the diesel engine should it start to 'bog down' such as on steep, boggy or sticky ground. The new drive train is said to offer fuel savings of around 50 percent when used as a pure diesel, along with significantly lower emissions. A new AGM maintenance-free battery pack can



Niftylift's new HR21 4x4 Gen2 Hybrid

be recharged either from an AC mains power source, or with the machine's 'Diesel-Ren' feature, with the engine's generator recharging the batteries twice as fast as an 13 amp plug. When the machine is used in diesel mode, any surplus power tops up the battery pack. The system incorporates a full battery management and protection system which monitors battery voltage, current and temperature to protect the battery pack and optimise the charging profile.

Genie's FE system

Genie's hybrid efforts date back to the 1980s when it began building Bi-Energy boom lifts, mainly for the European market in response to Niftylift's success. The company still offers Bi-Energy versions of its 34ft Z-34/22 and 45ft Z-45/25J DC. In 2014 it launched what it called a Bi-Energy Hybrid, in the form of its compact Rough Terrain scissor lifts - the 26ft GS-2669, 33ft GS-3369 and 40ft GS-4069. Unlike earlier Bi-Energy lifts, they employed four direct electric wheel drive motors and a large battery pack, while a small diesel engine with generator was available to top up the batteries even while the machine was operated. The new models provided a handy development step, perhaps refining a new hybrid concept leading to the launch in 2016 of the new 60ft all-electric Z-60/37DC which uses a similar direct electric drive train with four AC wheel motors. The Z-60/37DC was followed a month



Genie's Z-60/37DC articulating boom lift

later by a hybrid or 'Fuel Electric' version, the Z-60/37FE. The Hybrid model was essentially the full electric machine with the addition of a 24hp Tier 4 Final/Stage IIIB diesel generator to top up/recharge the battery pack or boost machine performance. The generator can recharge a fully depleted battery pack in around four hours but is also able to provide power directly to



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the AC wheel motors, boosting the power coming from the 48V AGM battery pack, helping the lift cope with steep inclines or particularly rugged terrain. The machine also offers regenerative braking, with the four wheel motors turning into generators when running down a slope or braking topping up the battery pack.

The Z60/37FE offers two modes of operation: 'Full electric' which can handle a full shift on a single charge, or 'Hybrid' mode which combines the diesel and electric power trains as required. The machine's system constantly monitors the battery state, with the diesel kicking in and when needed to top up the battery pack and then automatically shutting off to minimise fuel consumption. It is said to provide more than a week of operation on a single tank of diesel. The unit can handle 45 percent grades, has a ground clearance of 330mm and full time active oscillating axle. The FE units have been a success both in Europe - where there has long been an interest in such machines - and in North America which in the past has preferred simpler less expensive internal combustion models.

Last year the company extended the concept to its bestselling 45ft Z-45/25JRT articulated boom lifts, with the launch of the Z-45 FE, deliveries of which have been ramping up during the year. The Z-45 includes a Stage V Kubota diesel and a 48 volt 370AH battery pack. Genie has also updated the Z-60 FE with the same Stage V diesel plus a 390AH AGM battery pack.

A different approach from Manitou

Manitou has been doing a great deal of testing on both all electric and hybrid machines which form a key part of its Oxygen range of telehandlers and boom lifts.

While the telehandlers have yet

to make it into production, the company unveiled the all new, all electric four wheel drive 60ft 200ATJ E at Bauma last year. When it comes to the drive train Manitou has taken a different approach to Genie, Haulotte, Niftylift, JLG and others, eschewing electric wheel motors for its traditional telehandler off road axles with drive shafts to a central transfer box, which is driven by a large AC electric motor, rather than the usual diesel engine. This drive train has the advantage of using a single motor, mounted inboard high on the chassis rather than four smaller wheel motors that have to cope with mud, water and anything 'rough terrain' can throw at it.

A second electric motor located in the superstructure drives the hydraulic pump that powers platform movements, eliminating hoses through the slew ring. The 48 volt/460AH full traction battery pack is said to be more than capable of working an intensive full day shift.

Manitou says that keeping the relatively low voltage system allows technicians to work on it without special certification. The model is equipped with a new, easy to use control panel, with a screen in the platform that displays a wide range of information including accurate battery levels and a real time graphic display of the working envelope, platform position and overload warnings. Overall width is slightly less than the diesel model at 2.32 metres, while overall weight is 7,200kg compared to the 10 tonne diesel. Manitou says that the ATJ 200 E will have a 20 percent lower total cost of ownership when the fuel cost is included. Deliveries are due to have started, while a hybrid version - with an additional diesel generator - has been delayed due to the pandemic and is likely to appear early in the new year.



The battery pack is said to me more than enough for an intensive all day shift



The lift function motor and pump

Boldest intentions

Haulotte has made the most sweeping statements so far regarding strategies to tackle emissions and help the environment, launching its 'Blue Orientation' corporate strategy in April 2018, with the aim to replace all of its diesel machines with new, all-electric models in its new 'Pulseo' range. The first unit is the 61ft HA20 LE Pro - an all electric articulated boom lift with optional diesel generator - in other words a hybrid. The new machine has a full five year warranty, offers 11.91 metres outreach with an unrestricted platform capacity of 250kg, while the maximum platform capacity of 350kg is available at just over 10 metres, with an up and over height of 8.52 metres.

The next machines in the Pulseo series are almost ready for launch and is likely to include a telehandler. Haulotte said "The biggest challenge for all electric Rough Terrain machines is the access to electricity on job sites and the capacity to charge all the equipment." Given that this situation is likely to get worse rather than better, the hybrid solution makes good sense.



The new Manitou 200ATJ E



The new Hybrid is equally at home outside on site...



...and working inside on battery power

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The new Airo A18JRTH



Airo A18JRTH Plus

Italian aerial lift manufacturer Airo has a history of offering larger electric powered articulated boom lifts but it has now launched the true hybrid version of its new 54ft diesel powered A18JRTH Xtreme articulated boom lift - the A18JRTH Plus.

With a working height of 18.45 metres the new boom has an outreach of 9.9 metres with the unrestricted 300kg platform capacity, while the 400kg maximum capacity is available at up to 8.5 metres with an up and over height of 8.5 metres. The articulating jib can rotate horizontally by 130 degrees, while 180 degrees of platform rotation is standard.

The unit uses a similar drive system to the Manitou, with rough terrain axles with four wheel drive and four wheel steer driven by a large inboard mounted AC electric motor and a lithium-ion phosphate battery pack. It also features a Yanmar Stage V/T4F diesel and generator to top up the battery pack. Gradeability at 40 percent matches the Diesel 4x4 model. Tyres are solid, non-marking lugged RT tread, while total weight is 8,930kg.

The machine can be operated as a pure electric or as a 'Hybrid Automatic' where the engine powers up if the battery pack runs below a given level.

The batteries can be recharged with an onboard charger, via the



The Airo A18JRTH Plus uses an axle style drive train



The new Airo control panel.

engine or an optional remote 'Supercharger' which the company says can recharge the battery pack in two hours. The unit is wired for telematics, complete with a black box function recording functions etc. The first units have been delivered to Up Ag in Switzerland.

Dingli All Electric

Earlier this year Chinese manufacturer Dingli launched the all electric 86ft articulated EAB28ERT, the first in a range of all electric lithium-ion battery versions of its new four wheel drive, four wheel steer European designed boom lifts. It uses the same telehandler drive line as the diesel models, with full differential locking and shares most of the componentry, but the driveline is powered by an 80 volt/520Ah high capacity lithium battery pack feeding a large AC electric motor in place of a diesel motor. The machine is equipped with two charging modes, a 1.5 hour quick charge system and a six hour slow charge programme. The company claims that it can work for three to four typical eight hour shifts between recharges. The batteries - which carry a five year guarantee - are maintenance free and come complete with a battery management system. Should battery pack performance decline beyond 70 percent of the rated capacity within five years, they will be replaced free of charge.

Performance is the same as the diesels, including an unrestricted platform capacity of 230kg with a maximum working height of 28.1

The new 86ft all-electric 4x4 Dingli EAB28ERT



metres and an outreach of 19.1 metres at an up and over height of just over nine metres. The 28ERT will be followed by six other models, which include the 73ft EAB24ERT articulated boom, plus five telescopics - the 73ft ETB24ERT, 80ft ETBJ26ERT and ETB26ERT, 86ft ETB28ERT and 92ft ETBJ30ERT with maximum platform capacities of up to 454kg. At the moment the company has no plans to offer a diesel generator pack.

JLG

While it has been quiet so far this year on the hybrid front, JLG was one of the first to build an electric powered boom with automatic diesel recharging when it launched the lightweight - for the time - 60ft M600JP boom lift sometime prior to 2001. The machine has been a steady seller and a version remains

in production today.

In 2014 the company was also the first to introduce a 4x4 battery powered hybrid boom with four AC electric drive wheel motors in the H340 AJ, which also features a small Kubota generator which powers the machine directly, recharges the batteries or combines with the diesel engine to provide maximum power.

The move to hybrid machines is gathering pace but so is the all electric machine that can run all day and then some on a single battery charge. The challenge of access to electricity on job sites and the capacity to charge all the equipment, is essentially the same problem that dogs electric cars. And until that problem is solved, or an alternative is found, hybrid will have a place.



JLG's new lithium-ion battery pack



JLG's H340 AJ

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