



POWERED PEDALLING

With better battery technology and motors, electrically assisted bicycles have come of age in recent years. Chris Juden tests a pair of pedelecs

A pedelec is a bike (or trike) with an electric motor to help you pedal. That's been legal in Britain since 1983. A few years later, recognising that a little clean and quiet assistance could help some people keep cycling or take it up, CTC extended the full benefits of membership to pedelec users.

Early electrical assistance had a range of very few miles, before leaving you with an awful, heavy bike to push or pedal home! But now, thanks to lithium batteries and rare-earth magnet motors, all controlled by microprocessors, pedelecs have become much more practical and reliable.

Different countries' regulations

for electrically assisted pedal cycles vary in detail, but all restrict the motor power to something roughly equivalent to the uphill effort of a strong cyclist, whilst requiring the assistance to cut off completely at a speed such a cyclist will easily reach on the flat (200 or 250W and 15mph or 25kmph are the usual numbers).

Assistance: who needs it?

Starting off and uphill is where these motors help the most, which is good since that's where help is most needed. They even out the terrain, reducing the effort required to attain and maintain a reasonable speed to that of a flat road. So whilst a pedelec will be no challenge to a racer (except

maybe uphill) it should enable you to keep up with most cyclists without having to pedal as hard.

Exponents of 'the roadie work ethic' may object to such pandering to laziness – even claim it's not really cycling. It's easy for the able-bodied to scoff, but consider your older self, living where the hills that once uplifted your spirit have with the onset of arthritis or angina become prison walls. With a pedelec those walls may be climbed and a retirement paradise lost regained!

Electricity can assist with much more than an Escape to the Country. Many British towns grew with scant regard for terrain, or worse were actually planned that way, with any so-called cycling

(Above) Having the battery behind the seat tube means longer chain stays



(Above) The Trek has the battery high up, which makes the bike a little less stable

facilities interrupted every few yards by 'Cyclists Dismount'. Meanwhile decades of promoting home ownership alongside labour mobility have given British workers the longest commuting distances of any nation in Europe. With electrical assistance, some of those long and unfeasibly hilly, stop-start commutes can be made accessible by bike – without getting sweaty.

Pedelecs nevertheless have a role in improving health by making it easier for anyone to get cycling. Electric power replaces the anaerobic boost that a cyclist needs to start off or climb hills at anything more than a crawl. This enables a weak or overweight rider to exercise continuously within their aerobic limit, giving their heart and lungs a healthy workout and strengthening muscles without making them hurt. Because when something hurts, most people stop doing it!

So rather than being a diversion from proper cycling, electrical assistance overcomes some of the obstacles to a much greater use of bicycles. These obstacles are particularly prevalent in Britain, so we can expect to see many more pedelecs around here, now that they really work.

Pedelecs and E-bikes

The impetus for the 1983 Electrically Assisted Pedal Cycle (EAPC) Regulations was provided by Sir Clive Sinclair's determination to promote his ludicrous C5. We nevertheless got some sensible regulations, which

have subsequently allowed more practical cycles to be developed and used in this country. The main restriction is no assistance above 15mph, with limits on motor power and vehicle weight of 200W and 40kg for solo bicycles, or 250W and 60kg for tricycles and tandems.

Most European countries allow a bit more power and assistance up to 25kmph (equals 15.5mph) but cut it whenever the rider

A pedelec will be no challenge to a racer but should let you to keep up with most cyclists

isn't actually pedalling. In other countries, including Britain, you can also have a hand throttle and get power when freewheeling. Such twist-and-go models tend to be called 'E-bikes', with 'Pedelec' reserved for those with pedal-actuated assistance. But both terms are also used generically.

The motor speed restriction is the key factor that stops an electric moped pretending to be some kind of pedal cycle, but Britain looks set to fall in with Europe's pedalling rule. It helps that new models of pedelec will not in future have to go through type-approval (like motor vehicles) but can simply conform with EN15194: the European Standard for Electric

Pedal Assisted Cycles. Thus we'll shuffle our acronym to the more pronounceable 'EPAC' whilst getting another 0.5mph out of a slightly more powerful (250W) motor.

Existing E-bikes will be allowed to remain in use. And EN15194 does permit some power-assisted freewheeling up to 6kph. This option, where provided, should assist with pushing a heavy pedelec up any hill too steep to be ridden, or keep an elderly rider just about moving.

Bargain or known brand?

Pedelecs are the fastest growing sector of the European cycle market, one that mainstream cycle brands can no longer afford to ignore. But until now, most of the running in this sector has been made by entrepreneurs from outside the cycle trade, importing containers of electric bikes from China, where an explosion in demand has launched a whole industry, with few restrictions on what is ridden and how.

Earlier this year I was persuaded against my better judgement to test ride a new brand of pedelec – that shall be nameless. The importer promised it would be fun and so it was: to be pushed along effortlessly at well over 20mph. Fun but illegal, except with the registration, insurance and helmet required for an electric motorbike! He also said it climbed well, but the motor seized solid when I tested it on The Mount. In truth that's no mountain, just the biggest climb in Guildford. But it ascends 100m mostly at 1:10 with bits of 1:7. So I've made that my pedelec test hill, which I always ride with minimum effort so that the motor does most of the work. I didn't have time to discover how many times this bike could be recharged, but buyers should beware that a short-lived battery is another common deficiency of 'bargain' pedelecs.

If you need another reason to stick with big name firms, it's that a pedelec (unlike a normal bike, where any part can be replaced in any decent bike shop) depends on

some very specific components. Both the bikes featured here are from established cycle brands and comply with UK regulations (current and/or pending).

Power and range

On test rides I could feel the power assistance reducing above 14mph and by 15 I was clearly on my own. Both bikes give power only when pedalling with at least a little force, but they deliver this power and monitor pedalling in completely different ways. Neither of them assist with walking and pushing the bike, but I didn't find any hill steep enough for that. They both passed The Mount test without complaint or excess heat, maintaining a speed of 4mph-plus on the steepest sections.

Coincidentally, although they're different voltages, both cycles' batteries are lithium-ion with identical 260 watt-hour capacities, and that's the figure that matters. If both systems were equally efficient and if a rider used exactly the same amount of assistance, they should have the same range. In practice it's difficult enough to use the same bike the same way

Just one screw releases the guard to get at Kalkhoff's chain and view the Panasonic assist unit



on any two trips and although I followed the same (hilly) route in the same conditions, these bikes dole out the power too differently for me to do that.

I nevertheless reckon they're equivalent and the decision about which will suit you best depends on how you ride, rather than how far. But don't expect to go more than 40 miles on either, less if it's hilly and/or if the mid to high power settings are used.

KALKHOFF WITH PANASONIC

Kalkhoff might not be such a familiar name here, but it's a 90-years-old German brand with a factory in Lower Saxony assembling up to 3,000 units per day, mainly trekking and city bikes with a strong line also in pedelecs (which they call E-bikes). A few sporty models use the BionX system, but Kalkhoff get most of their electric assistance from Panasonic in the form of an integrated battery, motor and crankset. It requires a special frame design but is a proven reliable unit that's been used by several other cycle brands, notably Giant. And although pedelecs must be small potatoes for this Japanese electronics concern, Panasonic have recently made several improvements.

The motor drives the chain directly via a tiny (9T) sprocket tucked just behind the chainwheel. This sprocket can freewheel, so when the motor isn't helping you can pedal normally without dragging it round. The chainwheel isn't exactly fixed to the cranks, but has a few degrees of rotary float from which the unit measures how hard you're pedalling. It also indirectly measures your cadence and from these two factors, combined with the level selected on the handlebar-mounted control, it decides how much power to feed to the motor. The level determines not only the maximum amount of assistance but also how hard you have to pedal before getting any at all. High is for a weak rider who needs a lot of assistance, but even on Low you don't have to push

very hard to get a little help.

I used Medium to test the range and got 29 miles with 725m of climb. Battery status is indicated by three lights on the controller. One went out at 14 miles and 280m, another at 23 and 525. So when one light goes, you'd better turn for home, and with one light left you should be almost there. I reckon 100m climbed is worth another 2½ miles of flat road, on which basis the vendor's 50-mile claim seems reasonable. The battery is not too big to carry a spare in a pannier, nor the charger too heavy to take on tour.

Your mileage may vary, since not only hills but rider weight and pedalling effort make a big difference. The dominant factor with this system, however, is cadence. Slow pedalling is equated with a struggling rider so the system reserves maximum assistance (at whatever selected level) for when cadence drops below 40rpm. Pedal quicker and it's assumed you don't need as much help, so it tapers off with increasing cadence and by 65rpm you're completely on your own. However the bike is pretty good to ride like that, a bit heavy, but no worse than any moderately loaded bike.

It's a gears thing

Due to the influence of cadence, the road speeds at which you get anything from maximum assistance to none are determined by the bike's gearing, with top gear specified to give the required cut off speed. For most help, you need to keep in quite a high gear, since if you pedal fast, the help fades. This might not suit experienced cyclists who like to pedal briskly, but it's fine for the general public – who don't. At my normal cadence I got no help, but in that case I didn't need it and conserved the battery for later. When I came to a hill I simply delayed shifting down, allowing the bike and my legs to slow until the motor took up the strain. It didn't feel right to pedal that slowly, but it worked.

The advantage of Panasonic and other systems that drive the



Panasonic control on the Kalkhoff. Note that the Garmin eTrex isn't part of the bike's electronics

cranks rather than a hub, is that the motor, like the rider, benefits from the gearing of the bike. Since top speed is restricted by law, the only place this becomes an actual benefit is uphill, where by selecting a lower gear you're able to keep the crank-motor spinning at its optimum speed, whilst climbing more slowly than a hub-motor likes to turn. To be fair it takes an awful steep hill to defeat a good modern hub-motor, but if you have a few black arrows to cope with, you can be more confident of getting up them with this bike than most.

Since cadence is actually monitored via the motor, you can be assisted to spin a bit quicker if you fit an 11T motor pinion (available from 50Cycles). But then you should also change the hub sprocket to 24T, or else the top assisted speed becomes illegal.

There's also a derailleur version of this bike. It costs a bit less and uses the same frame, which has vertical dropouts, which is why this version needs a mech-like gadget to tension its chain. Given the role played by gear selection in controlling Panasonic's power, the derailleur version might even be a bit smoother. Not that the pause when shifting this bike's internal gears was a real problem, and the facility to shift down to 4th when stationary made for faster getaways.

A pleasure to handle

Although the Panasonic unit requires an unusual frame design, with much longer chain stays to

make space for its battery behind the seat-tube, a few inches on the wheelbase are a small thing compared to the benefits of keeping all the electric weight low and central between the wheels. It makes the bike appreciably more stable to ride, and easier to handle when not riding, than most pedelecs.

One design quirk is that the crank axle comes 16mm behind where you'd hope to find it. This makes an already steep seat-tube effectively steeper (the effective angle is given in the table) so I had to push the saddle as far back as it would go to get a comfy ride. A seatpost with extra layback would go well on this bike. Another oddity is locating the V-brakes on the opposite sides to usual. That's no problem at the rear and a good idea with all that empty space above the battery, but the forward rake of front forks skews the blocks of a rear-mounted brake so they bear unevenly upon the rim. It works okay but will be tricky to adjust due to the skewed rotation. A seatpost with more layback and a parallel-push V-brake are desirable component upgrades.

Generally, however, this is a well designed bike with some very high quality components, including easy rolling Top-Contact tyres and brilliant B&M LED lights. It may seem odd to power them by a dynamo when you've got such a huge battery on board (turning electricity into motion and back again!) but it ensures that you'll always get home safe.

ELECTRICS

Model	Kalkhoff Pro-Connect	Trek Valencia+
Motor location	Chainset	Rear hub
Motor power	250W	200W
System voltage	26V	41V
Battery weight	2.42kg	3.08kg
Battery dimensions	27x12x10cm	43x12x9cm
Battery capacity	259Wh	260Wh
Charge time	3-4hrs	3-4hrs
Battery price	£395	£1050
Charger weight	0.71kg	1.08kg

DIMENSIONS

Model	Kalkhoff Pro-Connect	Trek Valencia+
Frame size	505	445
Frame length	574	548
Seat angle	76.0	74.3
Head angle	72.0	71.0
Wheel size	696	694
Fork offset	53	48
Trail	57	69
Front centres	658	617
Chain stays	536	442
Wheelbase	1187	1052
Bracket height	284	285
Stand-over height	810	770
Reach	640-680	634
Crank length	170.0	170.0
Rear ends	135	135
Clearance	64	54
Rim diameter	622	622
Tyre section	37	32

TREK WITH BIONX

Trek have been building bikes in Wisconsin since 1976 and get their electric kits north of the border in Quebec, where BionX make the state of the art in hub-motors. With this system detection of road speed and pedalling effort is also at the hub, which means you can pedal the bike in any gear you like, it'll work just the same. And although BionX also claims to provide assistance in proportion to rider effort, the level you set on the handlebar control unit seems to be the main factor.

It's a levels thing

There are four assist levels and 3 felt closest to Panasonic's medium. However BionX have a much more sensitive battery status meter, which fell so rapidly at first – losing two of its 7½ bars in the first five miles of my test ride – that I switched to level 2. This uses only half as much juice, so I got a lot further than expected. Such a pessimistic battery indicator is not a bad thing if it scares the

user into conserving power like that, especially as the lights also run off the battery. After 38 miles, with 840m climbed and the gauge showing empty, they were still shining all right. Even the assistance still worked a bit, below 6mph only. It's like having a reserve tank.

Used less conservatively on a subsequent ride, the full assistance range equated more closely with Panasonic. But the systems behave too differently for exact comparisons. BionX gives more assistance closer to the cut-off speed, especially on level 3 or 4, and although the motor is rated 50W lower, it seemed to have just as much poke on 4 as Panasonic on high.

The stand-out BionX feature is regenerative braking, and whilst I remain unconvinced that it puts a useful amount of energy back into the battery, it makes a really good drag brake. Different levels of assistance or generation (down to minus 4) can be selected by clicking the A or G buttons on the controller.

They're a bit small and vague though. It's easy to press twice or the wrong one, especially in gloves in the dark, which is a nuisance when playing the levels to get the best from this system. Re-generation is also triggered by pulling the rear brake lever. With careful adjustment and a gentle touch, you can have strong electrical drag without the brake actually coming on – or changing levels.

With cables from hub to battery, to front lamp and controller and thence to brake lever, there's a lot more vulnerable wiring and connectors with BionX than the self-contained Panasonic unit. The battery incorporates the rear lamp and can also be removed for charging – not as neatly, but it can be charged in-situ if preferred.

Hill climbing was impressive for a hub-motor. As speed falls to 6mph the system piles on the power to keep the bike from going much slower, and on all the hills I tried it, this worked. On The Mount, this bike climbed slightly faster.

Sporty but a bit wobbly

Hub-motors and luggage-carrier batteries don't require anything special in frame design and the Trek Valencia+ simply adds the BionX system to a pre-existing hybrid. But that concentrates a lot of weight on the back and high up. This makes the bike a bit light and twitchy to steer, so it's not one I'm happy to corner or descend at speed on. Uphill, especially on power level 4, it's a bit too easy to pull a wheelie. If I were to add much luggage to this bike I'd want to put it on the front, though it already has a sturdy carrier on the back. Ideally this should be attached by stronger threads at the dropouts, since the deadweight of that battery loosens the usual 5mm screws all too easily. Check them often.

So the handling isn't great, but it's okay, you get used to it, and other aspects of the ride are good. Cycling enthusiasts who pedal at a high cadence will be glad to do that without losing electrical assistance. The wide range of gears will also appeal to those who want to go fast where they can, as well as climb hills easily.

It's quite a sporty bike, but with practical touches. The lights I've already mentioned. Mudguards are sturdy alloy and I like the way the front stays go to the low-load bosses. Like that, should the stays be caught on the tyre they swing out and away from it, probably freeing the obstacle. The bike also has a sidestand, unfortunately in the wrong place. It needs to supported the weighted rear end.

Disc brakes are a quality touch and they worked well once the alignment of both had been corrected. Adjustment of the fixed pad on the rear calliper will be tricky as the oversize hub gets in the way. The hub fits screw-on freewheels only, but the gears work fine.

A potential negative of hub-motors is drag from the magnets when turning it faster than the cut-off speed, or out of juice. However this one turns very freely when the power is off (maybe the motor freewheels on the axle), enabling the Trek Valencia+

(Below) The Trek's battery incorporates a good rear lamp.
(Bottom) The BionX control





Trek's BionX hub motor

to be ridden as easily without assistance as any bike this weight.

CONCLUSIONS

The Kalkhoff Pro-Connect is probably the best choice for older and overweight riders, or those entirely new to cycling, or anyone who mainly wants help with steep hills and isn't too fussed about speed. It also gives better acceleration from stationary.

The Trek Valencia+ will be preferred by cycling enthusiasts and younger riders who want to avoid getting sweaty on an arduous commute or to go as quickly uphill (almost) as on the flat. Cautious descenders will also appreciate the electric drag brake.

It's easier to carry a spare battery for the Kalkhoff and its charger also weighs less, but the Trek has front luggage potential and a wider gear range that can be pedalled at a more efficient cadence, so which bike to choose for holidays depends very much on how you like to tour.

We reckon to have picked two of the best such bikes to test, but for more on pedelecs it's worth reading a magazine that specialises in reviewing them, such as A-to-B (atob.org.uk) and/or Electric Bike Magazine (electricbikemag.co.uk). Another sound information source, with a useful forum, is pedelecs.co.uk.

SPECIFICATIONS

Model	Kalkhoff Pro-Connect	Trek Valencia+
Price	£1750	£1600
Weight	21.24kg	22.28kg
Gears	Internal 8-speed: 27–82in	24-speed: 24–101in
Frame	Aluminium alloy	Aluminium alloy
Fork	Aluminium alloy	Cro-Mo steel
Fittings for...	1 bottle, guards, rear carrier, wheel-lock, rear disc	2 bottles, guards, front low-load & rear carrier, wheel lock, disc brakes only
Tyres	Continental Top-Contact 37-622	Bontrager Race-Lite 32-622
Rims & spokes	Blackjack Warmup 17mm, 36x3 1.8mm black stainless spokes	Bontrager Nebula 15mm, 36x2 2.0mm front, 36x1 2.3mm rear stainless spokes
Hubs	Shimano dynamo N72 front, Alfine 8-speed rear	Shimano front, BionX 200W rear
Pedals	Wellgo Trekking Light	Soho alloy
Cranks	Concept alloy 170mm	Shimano M361
Chainrings	Steel 35T	Steel 28,38,48T
Sprockets	19T (x0.53, 0.64, 0.75, 0.85, 1.00, 1.22, 1.42, 1.62)	Sunrace freewheel: 13, 15, 17, 19, 21, 24, 28, 32T
Chain	KMC 3/32	Shimano HG-50
Front Mech	–	Shimano M191
Rear Mech	Shimano Alfine tensioner	Shimano Deore Shadow
Shifters	Shimano Alfine rapidfire	Shimano EF60 Rapidfire
Brakes	Shimano Deore XT V-brakes	Shimano M416 cable disc
Levers	Shimano Deore XT	Tektro alloy
Headset	Threadless semi-integrated	Threadless semi-integrated
Stem	Concept 100mm adjustable 0–50°	Bontrager 90mm 10°
Handlebar	Humpert City Trekking alloy 600mm, grips at 30°	Trek Urban alloy
Seatpost	Concept	Bontrager Nebula
Saddle	Selle Royal Lookin gel 30° Athletic	Bontrager H1
Rear carrier	Racktime with parcel spring	Bionx battery carrier
Mudguards	SKS 42mm	Bontrager alloy
Front Light	Busch&Müller Cyo-senso-plus-R	Busch&Müller IQ-Fly senso-plus-R
Rear Light	B&M Toplight Flat-plus	Bionx
Other Accessories	Atrax Stylo rear sidestand	Central sidestand
Manufacturer	Derby Cycle Werke GmbH www.kalkhoff-bikes.com	Trek Bicycle Corporation www.trekbikes.com
Supplier	50cycles Ltd, Loughborough 0845 604 7256 www.50cycles.com	Many local dealers