

All-night off-road events like Mountain Mayhem demand power and longevity



# Light up the night

Darkness doesn't have to circumscribe your cycling, off-road or on. **Michael Stenning & Chris Juden** explain what to look for in high-power lighting

**P**owerful front lights are essential for riding off-road at night – and even on road if you're riding at speed and have left the streetlights behind.

Dynamo systems will show you your way on unlit lanes when you're commuting or touring, but aren't so practical off-road and can't be spontaneously fitted to your road bike.

The good news is that rechargeable lighting systems offer better performance and value than ever. Ten years ago £200 bought a twin lamp 25watt rechargeable lead acid system with a run time of around 90 minutes, extending to about two and half hours when running a single 10W lamp.

These days you can get a similar unit – albeit with economies in materials and build quality – for a third of the price. Top-end lighting systems, on the other hand, weigh less, burn longer,

and now offer about as much illumination as a spaceship landing.

## Which light source?

### HALOGEN

In a light bulb an electric current is passed through a wire filament, heating it up to the point where it emits light. The higher the temperature the more light you get compared to heat, and the whiter that light is. Unfortunately the filament slowly vaporises meanwhile, thus bulbs burn out and the hotter the faster.

Halogen bulbs contain a gas that slows this process down, so they can be run at a higher temperature. Some manufacturers further enhance performance by 'over-volting' – so a 12-volt bulb might be paired to a 13.5-volt battery. The trade off is much shorter bulb life, but for some, increased performance outweighs





Left: by Gary Walls

such disadvantages. Bulbs can also be run at lower power to extend battery and bulb life, but efficiency falls dreadfully. An under-run bulb is a small heater, not so much a source of light!

### METAL HALIDE

Also called High Intensity Discharge (HID). These work by discharging an electric arc between two electrodes. The colour of light depends on the nature of the gas surrounding the electrodes. Metal halide vapour gives an even crisper, whiter beam than a halogen bulb.

HIDs are commonly found in motor vehicle headlamps and floodlights. It's hard to scale the technology down and bike-sized HIDs are not as efficient as stadium lighting, but comfortably outperform halogen nevertheless.

An arc is either struck or not, so you can't turn HID down to conserve power. Even turning off might not be worthwhile, since striking the arc

uses a lot of power, erodes the electrodes and involves a short warm-up period. They're better for shorter, technical mountain bike rides than for use on road.

### LIGHT EMITTING DIODE (LED)

The future of cycle lighting systems is already here. An LED is a semi-conductor that emits light of one specific wavelength or colour (e.g. red) when electricity passes through it.

LEDs don't naturally do white, but by combining a blue LED with a phosphor (a chemical that glows when radiation of any sort hits it) dyed yellow to mop up the excess blue, engineers have now produced a very good approximation.

These 'white' LEDs are getting better every year and now surpass the efficacy not only of halogen bulbs but also halide. Plus they can be dimmed without much loss of efficiency, making far better use of limited battery capacity (or slow uphill dynamos) than either of these old technologies. Systems delivering halogen-comparable output are still fairly expensive.

### How much power?

More sprockets on a cassette doesn't automatically equate to faster bikes, neither does a higher power lamp necessarily enable you to see better or further. Describing a system as so many watts only tells you how much electricity is going in. What matters is the amount of visible light coming out, which is measured in lumens and depends not only on the power but also the efficacy of the light source. This varies from: less than 10 lumens per watt for a typical cycle light bulb, or 15 to 30 with halogen; about 60 for HID; and for the latest LEDs it's up to 120 – and counting.

The number of lumens says nothing about the shape and spread of the beam, only the sum total of light produced. But as a rule of thumb you want at least 100 lumens for riding quickly on unlit lanes and 500-plus for technically demanding mountain biking. (One thousand lumens, incidentally, is *astoundingly* bright.)

Because of the inverse square law, in simple terms you need a beam that's four times more intense to illuminate something twice as far away. Concentrate the same number of lumens in a beam that's half as wide, and it should be about four times brighter. Most high-power battery systems employ very simple optics, so simple terms will do. Hence the traditional pair of lamps: a narrow spot for distance and a wide flood for close to. Their symmetrical cone-shaped beams waste a lot of light in the upward direction, but developments keep giving us more light to play with. And off-road one must also beware of low branches, after all!

The simplest, cheapest systems use off-the-shelf spotlamps designed for smooth illumination of stuff that's all about the same distance away, like a desk or sports pitch. Casting light obliquely forward along a road or trail is a very different proposition, requiring more sophisticated reflectors and lenses to optimise the balance of far and near



Experience the ultimate in convenience, power and reliability with the Solidlights XB2. Designed to get the most from modern hub dynamos using power LED technology, it's perfect for commuting, touring or Audax riding.

Weighing just 158g and housed in compact, super-tough aluminium alloy casing, it's seriously versatile. There's a choice of fork-crown mounting or a convenient quick-release handlebar mount. Professionally-made cables are included for easy installation and a neat, robust finish. It will run from hub dynamos or batteries (not included). It has a flashing mode for maximum visibility in town and includes a standlight to give you a few minutes of light even after the bike has stopped.

The XB2 is purpose-designed to light your way on unlit country roads so there's no need to compromise your riding after dark this winter.

For more information see our website at [www.solidlights.co.uk](http://www.solidlights.co.uk)

email [info@solidlights.co.uk](mailto:info@solidlights.co.uk)  
phone 01223 655611  
international +44 1223 655611

illumination. Comparing bike lamps by shining them on a wall won't reveal these subtleties; to see the benefit of the dedicated optics in more expensive modern systems you need to ride with them.

Road riding doesn't need as much spread, but demands a more concentrated spot to light further ahead – in proportion to the higher speed and extended stopping distance. If you don't want more than one lamp, a single, narrowly focussed high-power spot will do on road. Here a more sophisticated optical design really counts. The talk becomes less about total lumens and more about how many candela or lux you get in that central spot, since that's the key to distance and speed.

Since technology has given cyclists the power to dazzle oncoming traffic, it's become even more important for bike lamps to control the upward scatter. Tempting though it may be to give drivers a taste of their own medicine, a blinded motorist hurtling towards you isn't healthy! A top cut-off in a small bike lamp requires extremely precise, special lenses and reflectors, that only the biggest player in the cycle lighting business (generally those that also make car lamps) can afford to produce.

But enough of that: this article is primarily about off-road lighting, in which situation having two lamps of not-too-clever optical design actually works best. Combining a penetrating central spot and a broad spread in one lamp tends to leave a few markedly darker spots or stripes in the peripheral beam, which can be a distraction when the trail gets technical. A soft focus is better even if it doesn't really do the inverse square law thing. And two lamps have another advantage: some riders mount the narrower spot on their helmet, whence it can be directed exactly as required.

**“A single, narrowly focussed high-power spot will do on road. Off-road two lamps works best”**

### Batteries and burn time

Battery capacity is quoted in Ah or mAh (milliamp hours): 2400mAh is 2.4Ah. You can use this to work out the theoretical burn time for your lights. Firstly, work out the battery capacity in watt hours (wh) by multiplying its capacity in Ah by the battery voltage (V). Then divide this by the total wattage of the lamps that it's powering. For example, a 2.2Ah, 12-volt battery has a capacity of (2.2×12=) 26.4 wh and would power a 10W lamp for (26.4÷10=) 2.64 hours, or just over 2½. That's the theory, at least. In practice you seldom get the whole capacity, due to internal losses, less than perfect batteries or low temperature. Expect to lose around 10% of your theoretical run time.

More expensive systems use lighter, smaller, more sophisticated batteries. From least to most expensive, they are as follows.

### LEAD ACID

Lead acid rechargeable systems are now rather old fashioned. They're similar to the batteries used in cars (where light weight is not the issue it is for cyclists). Their main advantages are their low cost and easy charging. The two things that harm lead acid are too fast charging or being stored for long periods discharged. Fully charge them beforehand (e.g. over the summer months) to prevent them going flat. A lifespan of 300 charge cycles is possible.

### NIMH

Nickel Cadmium used to be the better alternative to Lead Acid, storing more energy in a given size or weight, less affected by temperature. Nickel Metal Hydride is a similar chemistry that's even more energy dense, less environmentally damaging and without the (irrelevant) memory effect. NiMH has now largely superseded both those older technologies.

Both varieties of nickel battery are vulnerable to over-charging and over discharge even more so, but can be charged very fast provided the charger is 'smart' enough. A smart charger detects subtle changes in voltage (delta-V) as the cell approaches full, then throttles back to a trickle.

Simple timed chargers typically take 8 to 12 hours, towards the end of which

## Light heavyweights

Here are just seven lighting systems that we like that will pack a decent punch at night. They're good examples of the better units available at their prices.



### Electron 5 + 10W front light system £80

A NiMH bottle battery powers a wide-beamed 5W lamp and 10W spot for 1.6 hours or up to 5 hours for just the 5W lamp. Includes smart charger. A cheap introduction to night-riding off-road.

[www.madison.co.uk](http://www.madison.co.uk)

### NiteRider Minewt USB £100

A 120-lumen Li-ion powered LED light that weighs just 175g (inc battery) and lasts 3 hours. Suitable for commuting and as an auxiliary helmet light when mountain biking, it can be charged at your desk via USB.

[www.2pure.co.uk](http://www.2pure.co.uk)



### Lumicycle NiMH system 2009 (one lamp) £125+

Lumicycle make super-powerful LED and Halide lights too, but their modular NiMH and Li-ion halogen lights are great on a budget because you can upgrade bit by bit. An over-volted 12W spot = 280 lumens.

[www.lumicycle.com](http://www.lumicycle.com)



### Light & Motion Stella LED 150L £199

Single LED lamp for commuting or use as a helmet light off-road, it weighs 200g and will produce 150 lumens for 2 3/4 hours down to 50 lumens for 7 hours, courtesy of its lightweight Li-ion battery. Includes smart charger.

[www.madison.co.uk](http://www.madison.co.uk)



### Lupine Tesla 4 £275

A lightweight (320g) single-LED lighting system whose clever optics let it put out 700 lumens for 2 3/4 hours and will run for 24 hours on its lowest setting. Suitable as a helmet light too.

[www.zyro.co.uk](http://www.zyro.co.uk)



### Exposure MaX-D £325

All-in-one (no cables) multi-LED lamp that weighs 320g but puts out 960 lumens for 3 hours. Ideal for mountain biking in the dark, it has a dimmer control for use on road, and will last 10 or 24 hours on lower output settings.

[www.exposurelights.com](http://www.exposurelights.com)



### Busch & Müller Ixon-IQ £100

By pointing the LED back into a computer-designed reflector, B&M get an intense central spot with sharp cut off. It's road legal and lasts 5 hours at 40 lux. The Ixon-IQ-Speed for MTBers is road legal too.

[www.amba-marketing.com](http://www.amba-marketing.com)







Splashing light around off-road is useful; on road, you need to avoid dazzling drivers

Left: i22 photography

they always overcharge unless the battery was flattened first. But flattening a high voltage (4.8V+) nickel battery risks a very damaging condition called reverse polarity. One way or the other you're going to ruin the battery with this sort of charger, so pay the extra for a smart one that'll take care of it for up to 1,000 cycles – as well as being faster.

#### LI-ION

The notable advantage of these over NiMH is low weight coupled with a higher energy density. However, they're costlier to produce given the lithium compounds used in their arguably more sophisticated construction and their charging requires very precise control of both current and voltage. Service life of Li-ion cells, while better than Lead acid at around 500 charge cycles, is roughly half that of a NiMH unit.

Lightweight Li-ions are the opposites of heavy lead in other respects. Whereas lead lasts better if stored full, lithium prefers to sit around empty and will lose capacity if fully charged and then left to go flat by itself. Stored half used is fine though. So don't recharge your lithium as soon as you get home, leave it until the day before the next ride. Fortunately lithium can also be charged fast, given a smart enough charger.

Whichever system you ultimately plump for, careful use, charging and storage (in addition to state of charge, cool and dry is important) will be required to get the full performance and economy.

Always spend the extra on a smarter, faster charger: it's life insurance for your battery. Charging time is a fair indication of quality. Under 6h is probably smart, 8 to 10 should at least have an internal timer, whereas 12h or more may simply be charging at a rate calculated not to do too much damage too soon during the inevitable overcharge. Best plug into a timer socket, lest you forget! That's a sensible precaution against malfunction with any charger actually.

#### Lighting and the law

Most high-power rechargeable front lights do not have DfT approval for use as your main front light. It's not a uniquely British or BSI problem. The situation is similar in most European countries, each of which has its own specifications for bike lamps, drawn up in tandem with the

regulation of motor vehicle lighting.

Motor vehicle lighting is now standardised internationally, but bike lamps are not deemed important enough for an EC Directive to sort them out. Chaos rules, but it suits a handful of (mainly German) lamp manufacturers to keep it like that!

Since bikes were only toys when America regulated vehicle lighting, they got missed. So anything goes over there and though Americans still don't cycle much, the proportion who do spend lots. Less developed countries are also laissez faire. Rather than try to steer a middle course through a plethora of sometimes conflicting national standards, it's easier to sell whatever is good for the rest of the world in Europe too, with an 'off-road only' label on it.

Such marketing works better in Britain than some other EC countries (Germany is very strict), since our regulations don't make any stipulations about additional lights – apart from the colour. But if you want to be fully legal you'll also need a token approved lamp.

The clearest indication of approval is a BS6102/3 mark. But there are other ways for a lamp to claim approval,

“Most high-power front lights do not have DfT approval for use as your main front light on road”

such as conforming to German regulations instead. The most interesting one for those seeking a legal fig-leaf is the recent special provision for flashing lights. If it flashes between 60 and 240 times a minute and is incapable of emitting a steady light (so it can't be tested to BS), a lamp of appropriate colour simply has to emit at least 4 candela. Four candles is no big deal for the latest white LEDs. Most flashers nevertheless miss out on approval by having a steady mode too. The only manufacturer to target this loophole accurately, I think, is Reelight ([www.2pure.co.uk](http://www.2pure.co.uk)), whose lamps don't even need batteries! This makes their SL120 an ideal 'token approved' lamp set.