



SHINING EXAMPLES

Technical Editor **Chris Juden** sheds light on generator hubs and compares five good ones, with the help of Olaf Schultz and Andreas Oehler

According to British cycling folklore, dynamos are unreliable, noisy, draggy things that slow you down and let you down. That was always an exaggeration and is now completely untrue. Modern dynamo lights don't even go out when you stop. A hub dynamo system is more expensive and more difficult to fit than equivalent battery lamps, but cheaper in the long run, since even rechargeable cells have a limited life. You also have the satisfaction of true self-sufficiency.

Nowadays it is even possible to charge your phone, GPS and camera battery off the same generator. Do that and your bike will not in the least be 'electrically assisted', but powered purely by your own glad effort!

GERMAN LIGHTING LAWS

Our last big article on 'dynamos' (most of them are really alternators) was in 1998 when I published the results of some German measurements of the power consumed and delivered by 15 different generators. All sorts were represented in that sample: 'bottles' and rollers driven off the tyre and devices attached to the side of a wheel, as well as internal hub generators. Most of them had pretty much the same electrical output, thanks to German traffic regulations that require dynamo lighting on every bike over 11kg and even specify

how many volts and watts are supplied to each lamp! These tests nevertheless revealed big differences in the amount of mechanical power required to produce that standardised output, which is perceived by cyclists as drag and is something we all want to reduce.

NOT SUCH A DRAG

A good way to think about this drag is in terms of riding uphill: how steep is the hill that would make you work that much harder? The answer, for the 'worst' bottle dynamos, assuming an all-up weight of 90kg, is a gradient of 1-in-300 or 0.3%. That's a rise of only 18 feet in a mile and if that's a hill, I'm a Dutchman! But tyre-drive also makes noise, and if you can hear something rubbing that really is a drag on your psyching!

Internal hub generators are silent and have much less drag: equivalent to ascending only five or six feet per mile, i.e. one-in-a-thousand. They're also much more reliable than things which run on the tyre or use tiny gears or belts to boost the revs. Over the past 15 years, several manufacturers have added many more models of hub, which have replaced other types of generator on all but the cheapest bikes. Even Sturmey-Archer, the original British inventor of the dynohub, now makes them again, but in Taiwan.

The single disadvantage of a generator hub, compared to those which totally disengage when not required in daylight, is that there is still some electrical drag when the lights are switched off and current can no longer flow in the windings. This drag comes from eddy currents in other metal parts adjacent to the still-turning magnets and should not be confused with the magnetic 'cogging' you feel when turning these hubs by hand. In some early designs of generator, eddy currents were so uncontrolled that you might as well have left the lights on! Six feet per mile isn't much to climb even so, but we can do much better. Lights-off drag for the Schmidt Original Nabendynamo (SON) equates to an utterly insignificant one foot per mile!

The cogging mentioned above does not cause any drag when the wheel turns continuously, since magnetic attraction balances repulsion. One may nevertheless be able to detect a slight vibration through the handlebars, which is more likely due to pulsing of the generated current, since it'll only be noticed when the lights are on. It has been suggested that this may cause numb hands on long rides, which seems improbable compared to ever-present and greater vibrations from the road surface that certainly do cause that problem.

Jan Heine, writing in *Bicycle Quarterly*, has combined dynamo data with the

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› results of tyre and wind-tunnel tests conducted by that magazine, and calculates that a hub switched on (or a cheap one switched off) knocks 1-2% off your average speed – and the best ones in daylight only 0.2% – whereas swapping a high-performance tyre for something more sturdy and puncture-proof will slow you by 10-20%. So your tyre choice (or pressure) makes ten times more difference than how you power the lights!

CLOSER TO THE SON

Since 1998, new models from **Schmidt** and other manufacturers have brought some slight improvements in efficiency and modest weight savings, but the main challenge, particularly for Shimano and the rest, has been to reduce lights-off drag to something like the SON. They've got pretty close and in this review I'll compare Schmidt's latest and lightest creation with the best on offer from the following three competitors.

- **Shimano** of Japan needs no introduction. Their original Inter-L was a signal to the dynamo lighting market that hubs were back in town – and not just the rich suburbs. They've since made many technical improvements and promoted this technology up to the Deore XT level. Their base models are also much enhanced and nevertheless remain competitively priced.

- **SP** stands for Shutter Precision and SP-Dynamo is a new venture for this Taiwanese manufacturer of camera shutters – for which I guess there's less demand since photography went digital. They make lots of hub designs but all with the magnets arranged radially in a disc with the armature on either side, rather than the usual cylindrical arrangement. A central magnet disc gives this compact hub its bi-conic shape.

- **Supernova** have generators made by SP, with different aesthetics and upgraded weather seals for the German market – where durability counts. Infinity-S is based on the SP model tested, hence the similar shape. Infinity-8 is the joker in this pack: Supernova's version



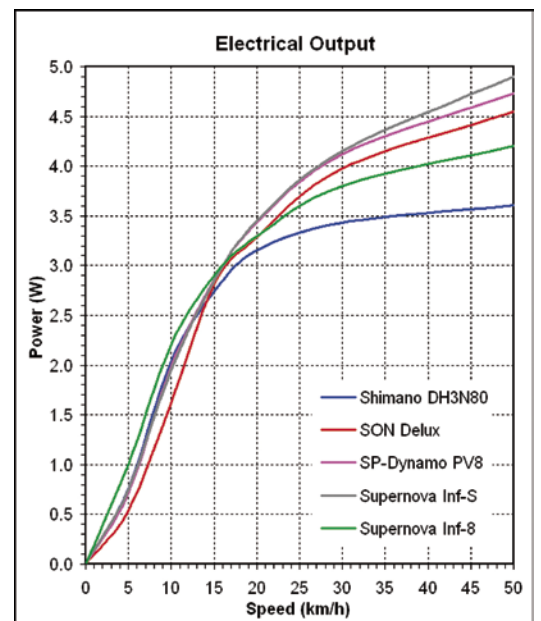
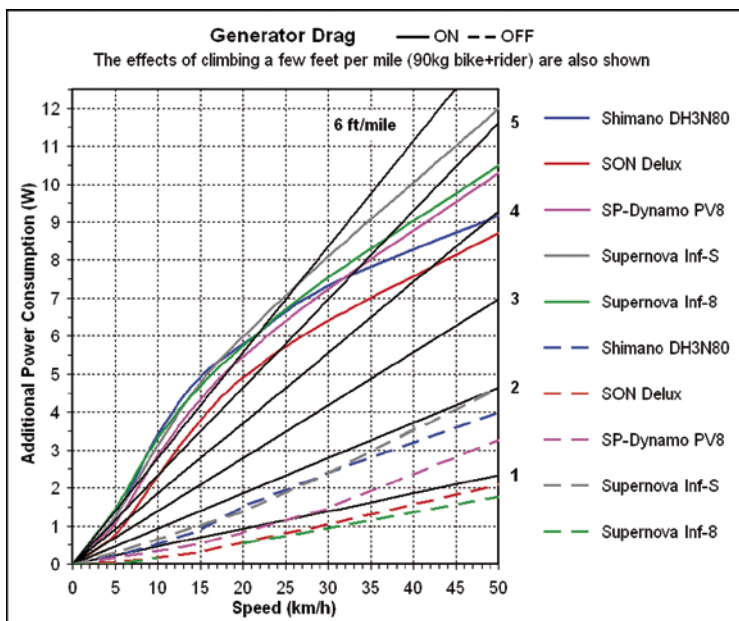
In the photos
 1 The test rig
 2 SON-28 is the original SON brought up to date. It delivers extra power at low rpm – as required by slow riders and big '29er' wheels

of an SP design that mechanically disengages the magnet to let the hub spin free.

HOW THEY WERE TESTED

These hubs were tested independently by Olaf Schultz in Hamburg. His apparatus mounts the hubshell in a lathe chuck and turns it at a set speed whilst measuring the drag force on a lever attached to the axle. Electrical output is monitored with a 12 ohm resistance, since that's how it's always been done, as bulbs are also resistors. But LEDs are diodes, and alternators naturally perform much better with those, especially if both components play to their strengths. Actual power output may therefore be significantly greater when a generator is used with matching lamps.

When you fit one of these generators to your bike it takes the place of a normal front hub, which is not without a little drag itself. So I subtract this small amount from each hub generator's input power figures. In my previous review I subtracted the drag of a high quality hub measured by Andreas Oehler on a different rig at Schmidt Maschinenbau (upon which ›



> the previous generators were also measured). That method may have included some aerodynamic drag.

Whatever: those old figures for plain hub drag are greater than Olaf's figures for an SP generator with disengaged magnet! After consulting with Olaf and Andreas, I have subtracted a set of values that represent a very high quality free-running hub. If your bike has an inferior hub, and you replace it with the best generator, it might go even better – in daylight at least!

Olaf Schultz and Andreas Oehler have between them tested a great many generators. I've picked just a few of the high performers, ones that are available in the UK and that I've handled myself. The many generators tested include three samples of the SP-Dynamo PV8 and two of the Supernova Infinity-S. My figures for each of these models are averaged from those results. Comparing these samples shows that one model can vary by more than the apparent difference between models, so one should ideally test lots of samples of each. But this is not an ideal world. Look on the bright side: you might be luckier with your sample!

If you'd like to read about the rest of the hubs, I'll publish some more information on the CTC website – including my 1998 Dynotest. You can find other internet articles derived from this data at bicyclequarterley.com and fahrradzukunft.de.

GRAPHS AND DATA

I've condensed three tables of data into a couple of graphs (which you can view larger online) to illustrate the small but significant differences in electrical output and mechanical drag between the models of generator reviewed here. I've also extracted some key statistics and added them to the comparison table, with the top and bottom performers in each category indicated in bold and italic text.

In that table the Price is full retail (some of these hubs can be bought much cheaper) and Weight is without a skewer (a typical lightweight front hub is 160g). I've given the electrical output Power at 10km/h (6mph) because it's when you're going slow that the light dims and differences really show. Efficiency (the ratio between output and input power) is what you want overall, so I've rated that at an average speed of 20km/h (12½mph). Speed merchants obsess about Drag, so I've >



In the photo
Exposure's Revvo: hub dynamo lighting is now powerful enough for use off-road

DYNAMO HUBS HEAD TO HEAD

The best performance in each category is indicated by bold text; the worst performance by italic text.

MAKE & MODEL	PRICE £	WEIGHT g	POWER AT 10km/h W	EFFICIENCY AT 20km/h %	DRAG AT 30km/h		WARRANTY YEARS
					ON W	OFF W	
Shimano DH3N80	£110	483	2.03	55	7.32	2.40	1
SON Delux	£180	384	<i>1.61</i>	67	6.39	1.05	5
SP-Dynamo PV8	£90	386	1.97	63	7.25	1.48	2
Supernova Inf-S	£175	398	1.95	58	<i>8.09</i>	2.39	2
Supernova Inf-8	<i>£185</i>	676	2.20	57	7.54	0.94	2

1 SHIMANO DH3N80

THE DEORE LX hub pictured (and used by me for a year or so) is a DH-T660-3N, not the XT model tested by Olaf. But they're electro-mechanically similar, which means you can have the same performance for £20 less and a couple of ounces more. And it's a much improved performance on Shimano's first generation: one quarter the daytime drag and all other aspects slightly improved. These hubs have aluminium windings to save weight and much better seals – which are needed since it's beyond the ability of most bike mechanics to dismantle the right-hand bearing for maintenance. That said, these hubs last pretty well. Center Parcs' entire adult fleet is

equipped with cheaper Shimano models that keep on generating for years despite being outside 24/7/52!

Shimano's best doesn't manage a top score in any area and is bottom in three, but it comes close to hubs costing almost double. Perhaps its best selling point is availability – often at a substantial discount on the RRP. Shimano products are imported by madison.co.uk. See <http://cycle.shimano-eu.com> for more information



2 SON DELUX

NOT CONTENT to rest on their laurels, the first improvement by Schmidt Maschinenbau to their excellent Original Nabendynamo was to add something no other hub has: a barometric pressure compensator. This stops the hub sucking damp air in via its bearings when it goes out in the cold, so it won't get rusty inside. It's an expensive generator, but is built to last.

With the Delux, Schmidt maintain their lead with the smallest, lightest and most efficient generator hub on the market. Daylight drag is now only inches per mile. Low-speed power doesn't look so good, but that's because it's optimised for Schmidt's Edelux LED headlamp. It's fine with other headlamps, but

with that one it's a star performer.

The full Delux range includes center-lock disc and 'Widebody' versions, the latter with flanges further apart to resist buckling. Schmidt products are imported directly by discerning dealers See nabendynamo.de for more





“LED-OPTIMISED GENERATORS AND LAMPS WILL BECOME THE NORM IN FUTURE”

provided the 30km/h (19mph) figures, with lights on and off. Finally the Warranty gives some idea of how durable each manufacturer thinks his hub might be. It should last very much longer, of course.

Wheel size matters. These measurements assume a 700C wheel. Smaller wheels turn faster at a given road speed, so you'll get more watts out and have to put more watts in. By 20 inches (500 size) and under, you'd better use a smaller generator.

THE FUTURE

Most LED lamps contain circuitry to make them compatible with generators that are optimised to drive bulbs. But bulbs are now obsolete and as they disappear from cycle lamps I think that LED-optimised generators and lamps, like the SON Delux-Edelux partnership, will become the norm and efficiency gains will trickle down to lower price points.

White LEDs have improved so much that the German authorities acknowledge that less than 3W may now suffice to light up a cyclist and are in the process approving 1.5W LED systems. A prototype generator from Shimano has been tested, and whilst it almost halved the lights-on drag, its daytime performance was disappointing. There's really no point in turning it off, but this is early days and improved hubs will surely follow German approval. A watt-and-a-half should be enough to keep your phone/GPS/computer running and your electric shift accumulator full, so maybe you won't want to turn it off! ☺



In the photo
Even when you factor in rim, spokes, and a wheel build, long-term costs are low

3 SP-DYNAMO PV8

THIS NEW hub hits the ground running with the keenest competition Schmidt has seen in years – and at half the price!

The hub illustrated is the similar PD8 6-bolt disc version I had on loan from Ison. Note the thick ridge in the centre where the magnet disc is retained in this radically different design of generator. Lighting is connected via the same form of plug and socket as Shimano – handy, as that's what I had on the bike already. It worked just as well as the usual sort of generator and rolled very nicely. I hope users will let me know how it fares long-term, for this mix of performance and price is sure to be popular.



SP-Dynamo also offer a switchable model. It's the basis for Supernova's Infinity-8 but has much less drag when the magnet is disengaged. Early models had reliability issues, but these may now be solved.

All SP-Dynamo hubs are imported by ison-distribution.com. Visit sp-dynamo.com for more

4 SUPERNOVA INFINITY-S

THE SIMILARITIES with SP-Dynamo's PV8 are obvious. Electrical output is as close as makes no difference but the Infinity-S has greater drag. It's not a huge amount more, but it's there and very consistent between the On and Off data: half a watt at 20kmph and one watt at 35. I think it's almost certainly down to the extra bearing seals specified by Supernova and may disappear as these run in.

As it comes, however, the Infinity-S isn't quite tops for anything and I'm struggling to work out who would *not* pay a few quid more for a SON Delux; maybe someone who's trading up from a Shimano generator and does not wish to swap their quick and easy connector for two less

convenient spades, or someone who wants a full Supernova system – their lamps are something special.

All Infinity-S hubs have a Shimano 'center lock' disc mount, but there's a choice of black or grey salt-resistant anodised finishes. Supernova is imported by amba-marketing.com



5 SUPERNOVA INFINITY-8

THIS IS SUPERNOVA'S version of the SP switchable. In this design the magnet disc is to the right of the windings and most of the armature. It is secured against this side of the hub shell by turning a five-lobed ring backwards, against the direction of wheel rotation. Stop the bike, turn the ring forwards and this unlocks the magnet, moving it leftwards and parking it on the armature. Move off and it stays there, letting the hub shell spin free. But only relatively free.

This hub, which should spin just as freely switched off as a normal hub, has about the same amount of residual drag as the difference between the Inf-S and PV8 noted above. I think it's those Supernova

seals again. They'd better be worth it!

The lop-sided armature is efficient, scoring tops for low speed power. Like its Infinity stablemate the '8' has a Shimano connector but gets a more bulky 6-bolt disc mount.

As it comes, the Infinity-8 shows no significant advantage over a SON Delux. And it costs even more. [See supernova-lights.com for more](http://Supernova-lights.com)

