Perpetual motion machine

Chris Beeson goes sailing with a genius, aboard a boat packed with radical technology. She generates all her own power and fresh water, never needs refuelling – and she will change the way we sail.

We were motoring through Amsterdam in his revolutionary 44ft catamaran, Green eMotion, when Gideon got a phone call from the electricity company. Their records showed that the national grid had received 4,000kW from his house in the last four months. They didn’t believe it. ‘I told them that’s the spare energy I’ve produced. They must pay me the same rate I pay them.’

By the time you read this, Gideon’s home will be totally energy self-sufficient, thanks to solar, wind and geothermal energy. ‘I could power half the houses on the street, but it’s cost me £335,000 to go fossil-free,’ he said.

She never needs to refuel

Green eMotion is a comfortable, fast cruiser. Because she’s so light, she has logged 109 miles in five hours, attaining a top speed of 30 knots. ‘Never again!’ said Gideon. ‘The boat can take it, my heart can’t.’ She’ll average 8 knots on passage. She is packed with cutting-edge technology. The marine industry has much to learn from her.

The heart of the set-up is Green Motion: two electric ‘motogens’ (motor-generators), built into lifting saildrives. When there’s no wind, these can power her at 6 knots for three hours, or 5 knots for seven hours. When the wind returns, they generate electricity or lift clear of the water to reduce drag.

It sounds simple, and it is, but making it work has so far evaded all the major boatbuilders. Many have tried – and failed. Gideon founded African Cats in Durban, South Africa, to turn his hi-tech vision into reality and now he’s building boats to fulfil other people’s dreams.

The first boat, African Innovation, was launched in 2004. The basic African Cats 445 costs £416,600 and the 10kW Green Motion system adds £41,600. The fully-equipped boat seen here costs £583,210. There are also 20, 30 and 40kW Green Motion systems.

Carbon fibre mast weighs just 20kg

The tenth African Cat on order is a 61ft carbon fibre cat built for a surgeon who works with Médecins sans Frontières, and it has a fully equipped operating theatre in the starboard bow. The doctors will sail to remote South Pacific islands to provide much-needed medical care. Designed by South African duo Simonis-Voogd, she will run on Green Motion, with two back-up diesel gensets to guarantee power during surgery.

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Gideon Goudsmit, 58, has spent seven years of his life and over £1.6 million developing an ocean-going yacht that needs no fossil fuels and generates all the power she needs. His obsession with capturing natural energy has crossed over from home life to sailing life.

Not having to worry about refuelling opens up a wealth of cruising possibilities

PBO fibre rigging: ultra-light and super-strong

These polycarbonate windows are 250 times as strong as glass and 100kg (220 lb) lighter

A brand-new boatbuilding material – basalt fibre!

Carbon/hyde ball studs make for safe grounding and allow her to be beached

A brand-new boatbuilding material – basalt fibre!

Carbon fibre mast weighs just 20kg

Lifelines are Dyneema rope instead of wire. Stanchions are carbon ski poles

Four heavy-duty solar panels on the bimini and has on the cabin top generate most of the electricity the boat needs

Propellers generate electricity while you sail

Dyneema trampoline: quick draining, comfortable to lie on, ultra-light and immensely strong

Laminate sails made from Spectra and carbon fibre are lighter and hold their shape for longer

‘Gideon Goudsmit has spent over £1.6 million developing a yacht that needs no fossil fuels and generates all the power she needs’

Green eMotion is the product of one man’s obsession with saving weight and crossing oceans without using fossil fuels
THE FUTURE OF CRUISING

Revolutionary construction

The lighter a boat, the less her wetted surface area and the less power is needed to drive her through the water. Gideon removed 200kg (440 lb) to reduce draught by 1cm (0.4in)

Mast and rigging

Green eMotion’s carbon fibre mast, built by Southern Spars, weighs just 92kg. The forestay is Dyform wire, the mast’s jumpers are solid fibre, with wire rigging on the bottom metre, which makes it easier to adjust the fixed-length PBO stays.

Green eMotion’s hydraulic, bronze twin-throw unit weighs 10kg (22 lb). Gideon commissioned a new design from a Slovenian company, which weighs 1.4kg (3 lb 2oz).

Gideon’s remarkable inspiration for his new composite materials came from basalt fibre. The lighter a boat, the less her wetted surface area and the less power is needed to drive her through the water. Gideon removed 200kg (440 lb) to reduce draught by 1cm (0.4in). The vacuum is released 24 hours after infusion is complete. The deck is one-piece, built from foam-cored carbon fibre. Gelcoat weighs 0.4kg/m² (0.008 lb/sq ft), so Gideon uses two-part spray paint, which is 95% lighter. Finished GRP, with gelcoat inside and out, weighs 12.5kg/m² (2.56 lb/sq ft). Foam-cored basalt fibre, vacuum-infused with epoxy resin and painted, weighs 5.5kg/m² (1.15 lb/sq ft). Using carbon fibre reduces that to 4.8kg/m² (0.98 lb/sq ft), nearly a third the weight of GRP.

Hulls

A camera tripod made from basalt fibre was the inspiration for Gideon’s remarkable choice of construction material. It’s lightweight and strong. The Russians call it poor-man’s carbon fibre, he says. It’s 2% heavier than GRP but 26% stronger, so you can use less of it, and much safer to work with – you don’t need to spend an hour in the shower after using it. And it’s natural – the earth produces 3 of basalt every year. Gideon commissioned the Universities of Durban and Leuven to assess its suitability for boatbuilding and in 2008 basalt fibre was CE-approved for yacht construction. It’s expensive – £8.54/kg compared to £2.14/kg for GRP – but cheaper than carbon at £42.70/kg. The lighter a boat, the less her wetted surface area and the less power is needed to drive her through the water. Gideon removed 200kg (440 lb) to reduce draught by 1cm (0.4in). The vacuum is released 24 hours after infusion is complete. The deck is one-piece, built from foam-cored carbon fibre. Gelcoat weighs 0.4kg/m² (0.008 lb/sq ft), so Gideon uses two-part spray paint, which is 95% lighter. Finished GRP, with gelcoat inside and out, weighs 12.5kg/m² (2.56 lb/sq ft). Foam-cored basalt fibre, vacuum-infused with epoxy resin and painted, weighs 5.5kg/m² (1.15 lb/sq ft). Using carbon fibre reduces that to 4.8kg/m² (0.98 lb/sq ft), nearly a third the weight of GRP.

Windows

The large windows are Lexan Mangard, a polycarbonate sheet that has 250 times the impact resistance of glass. It’s also abrasion-resistant, UV-stable and lightweight, saving 100kg (220lb) over the glass alternative.

Wiring

By using a Cap2 power distribution system – an electronic spine through which power is supplied and data exchanged by the boat’s various systems – Gideon saved 120kg (265 lb) of weight, primarily copper wire.

Sails

The sails are Spectra and carbon fibre cruising laminates, made by North. Gideon says these offer the best combination of light weight, longevity and shape retention, which is essential for efficient sailing.

Keels and rudders

Green eMotion can be beached. Each hull has a keel stub, like a small daggerboard, to limit leeway. The edges are carbon fibre and Kevlar to cope with the abrasion of grounding. The core is made of Coca composite rather than marine ply, a saving of 10kg (22 lb). The rudders are foam-cored basalt fibre and Kevlar, on aluminium stocks. Gideon experimented with carbon fibre but found electrolysis where the carbon rudder skin and aluminium stock were in contact.

Lifelines and stanchions

Gideon saved 14kg (31 lb) by replacing the stainless steel wire lifelines with Dynema rope. It’s legal for cruising, but not for racing. Gideon is replacing Green eMotion’s steel stanchions with carbon fibre sections, saving 10kg (22 lb). He made them by pushing a carbon ski pole inside a carbon Nordic walking pole, with a layer of resin-infused carbon in between. The stanchions have a spraypaint finish and stainless steel fasteners. The trampoline didn’t drain fast enough. Once, it took a wave and collapsed under the weight, almost taking Gideon’s wife, Eike, with it. He designed the perfect tramp – quick draining, comfy to lie on, strong, light and UV-stable. His Dynema net weighs 20kg (44 lb) less than a regular tramp. It’s now being used by other builders.

Compressed beam

Many boatbuilders use a boom section for the compression beam, which runs between the forward beam and the mast. Gideon designed his own to save weight and improve performance. The section has a V-form below to reduce wave impact, tracks either side for the slides holding the trampoline fastenings and a flat section on top to walk on. It’s now used by several boatbuilders.

Cork sole

Instead of the usual teak-and-holly veneered marine plywood, Gideon chose cork. It’s lightweight, an excellent insulator, feels good underfoot and if a slippery plate exacerbates while washing up, it doesn’t break when it lands.
**Domestic systems**

To test the boat's generators, she is loaded with every possible appliance: microwave, fridge and freezer, dishwasher, air conditioning, watermaker, electric induction hob, electric ovens – even the saloon and cockpit tables can be lowered on electric legs. Domestic systems, however, run on the minimum of power. The water-cooled fridge and freezer draw 2A per hour. The motogears are water-cooled, too – and their run-off heats water in the calorifier. She has LED lighting inside and out, the warmth of which convinces me that halogen has had its day. A ‘Quooker’ tap delivers boiling water on demand, using very little power and saves you having to boil a kettle. Everything has a safety breaker, and a dump regulator dissipates any excess power.

The bus bars will be downstaged. The green dump resistors dissipate excess power.

The Schlenker watermaker is fitted below the boat’s diesel generator. Green eMotion also has an air conditioning unit.

**Batteries**

Gideon has a 9.6kW electric system, enough power to keep all systems running at sea and has actually increased in capacity by 5%. The Li-ion batteries cost €4,000 ($2200), and have had its day. A ‘Quooker’ tap delivers boiling water on tap for drinks, an espresso machine and a dishwasher.

**Wind generator**

Gideon used to have two Air Breeze wind generators pole-mounted all the cockpit but they never delivered the amps expected. Now he has an Eclectic Energy D400 mounted at the masthead, around 21m up. In stronger breeze and clearer air, the masthead unit delivers on average 1000W per hour, more than twice as much electricity as a pole-mounted unit. In 7 knots of average wind speed, I noted the wind generator was delivering 5A at 218v, about 140W. And the masthead mount makes the turbine’s noise and vibration far less intrusive.

**Solar panels**

Three of the four Sunpower 300W solar panels on the rigid bimini and coachroof supply the propulsion bank while the fourth supplies the domestic bank. They weigh 15kg (33 lb) each, but Gideon expects the next generation will be lighter and more efficient.

**Converter and inverters**

There are six Mastervolt converters, one on each of the six propulsion generators, to ensure even charge distribution, and two other custom-designed, US-built converters, one from 25-550v and one 150-250v, the boat's two systems. There is also a Victron Quattro 5000, a 4kW inverter, that delivers the 230v AC, 50Hz required by the Smeg induction hob and electric oven. Victron and Mastervolt thought the AC output would not be clean enough to power the hob but the system works perfectly. There’s also a 220v AC shore power and, if Gideon fits an inverter, he can send into the grid any extra power he generates.

**Generator**

The 22kW generator can recharge the batteries during extended calms, but is rarely used. It has been significantly modified to lower weight and improve efficiency to around 8%. Simply by turning the generator, Gideon has managed to get the same power at 2,200rpm that he used at 2,400rpm. Engine mounting were changed from stainless steel to carbon fibre and the plywood base has been replaced with Cosa composite, bringing the total weight down to 212kg (467 lb). Now, though, Gideon has found a new 40kW generator that weighs just 95kg (209lb).

**Technical**

**Price guide**

£700,000 (€822,500)
LOA 13.4m (44ft)
LWL 12.90m (42ft 6in)
Beam 7.49m (24ft 6in)
Displacement: Buoyant. 6,400kg (14,110 lb)
Carbon 5.800kg (12,787 lb)
Sail area 135.5m (2.720sq ft)
Water 605 litres (132 gal)
Cabin 2
Engine 2 x 9.6kW (26hp)
Designers: Angelo Lavranos and Gideon Goudsmit
Contact: African Cats
Tel 0031 297 528281
Web www.africancats.com
Zeal, passion and knowledge

‘I’ve always been an inventor,’ Gideon says. ‘When I was 12 my parents had a small castle in the Dordogne with a stream running through it. I used bicycle generators to make electricity from the river.’

Gideon was well ahead of the game when, in the 1970s, he designed three carbon-free offices with wind generators, solar panels and triple glazing. There were also heat sinks in the thick, heavily insulated floors that captured the heat produced by staff and office equipment during the day, stored it overnight and released it by time delay switch an hour before staff arrived. The buildings are still running today.

Though the Goudsmit family made its money with land, Gideon amassed his personal fortune when, on the eve of the millennium, he sold his car dealerships – a puzzlingly ironic business for someone so environmentally aware.

After owning various Moodys and Hallberg-Rassys, Gideon wanted something quicker. ‘On an ocean crossing, a good average speed for a 40-45ft monohull is 5–6 knots,’ he said. ‘I wanted a lighter, faster boat. I visited nearly every French multihull yard, but I couldn’t find what I wanted.’ He eventually bought a St Francis 48 cat in South Africa, but soon had a list of 500 things he wanted to change. So in 2001 he asked Angelo Lavranos, who had designed the St Francis 48, to go back to the drawing board. They worked together for six months perfecting the design, before founding the African Cats together.

Proof that it works at sea

Green eMotion sailed from Durban to the Azores, then on to Amsterdam, a passage of 8,000 miles. In three months, seven weeks of which was spent on passage, she used 274 litres (60 gallons) of diesel, mostly in the Doldrums.

Without time constraints, or with better weather routeing, the voyage could easily have been made without any fossil fuels. It’s encouraging that boatbuilders are contacting Gideon about the Green Motion system, but he still sees room for improvement. ‘You will generate four times as much electricity at 10 knots as you will at 7 knots,’ he said. ‘By adding some propulsion while generating, we can generate even more electricity than we use.’ He is working with the Slovenian company that makes his throttles to develop software that automatically calculates the settings for optimum electricity generation.

Passion and know-how

Gideon’s passion and phenomenal knowledge about the boat is absolutely compelling – it’s no surprise he made a fortune in sales. Whatever I pointed to, Gideon knew its weight, its construction, how it performed and how it could be improved. The result of his zeal is a project strewn with firsts: the first ever basalt fibre yacht; the biggest vacuum-infused carbon structure ever built; the first ever fossil fuel-free, ocean-going, luxuriously appointed performance cruiser.

The boatbuilding industry is already reaping the benefits and the inventions that have emerged from his project have dragged forward research in this area by a decade. With fuel prices rising, fuel quality falling and an ever-increasing list of environmental requirements in the most beautiful parts of the world, there’s no doubt the market is ready for a boat that uses no fuel. If Green Motion doesn’t win every major ecological award in the marine industry next year, then I’m a Dutchman.