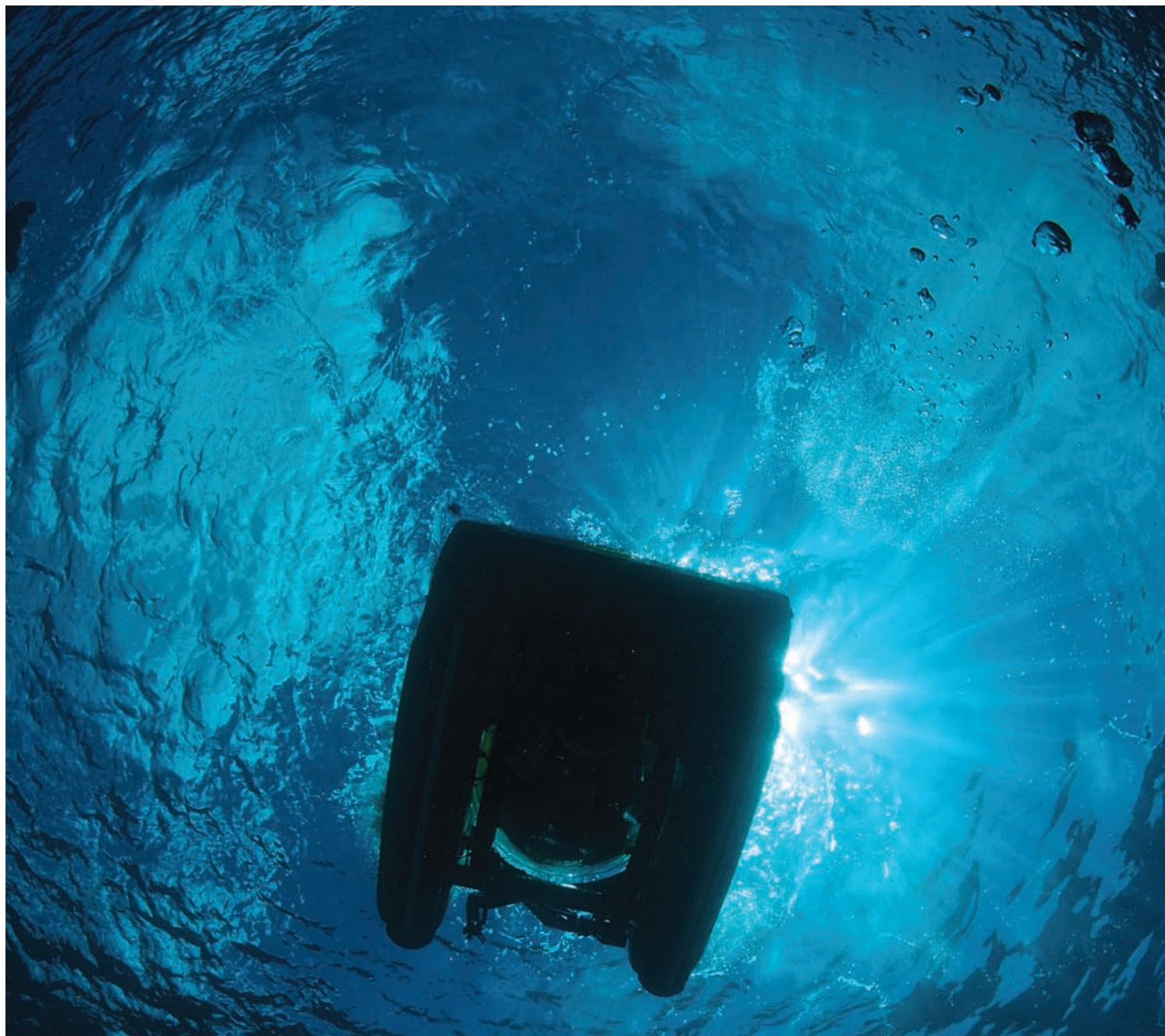


The Superyacht

TRUTH • OPINION KNOWLEDGE • IDEAS AND EXPERT INDUSTRY ANALYSIS



REPORT

SANLORENZO

The company chairman and CEO discuss the brand's business strategy and its position in the global market.

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MICROTURBINE GENERATORS

A system offering innovative technology combining silence and ease of use with cleaner operations.

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THE FUTURE IS ORANGE

The Dutch market leaders reveal what they think superyachting will look like in 2020.

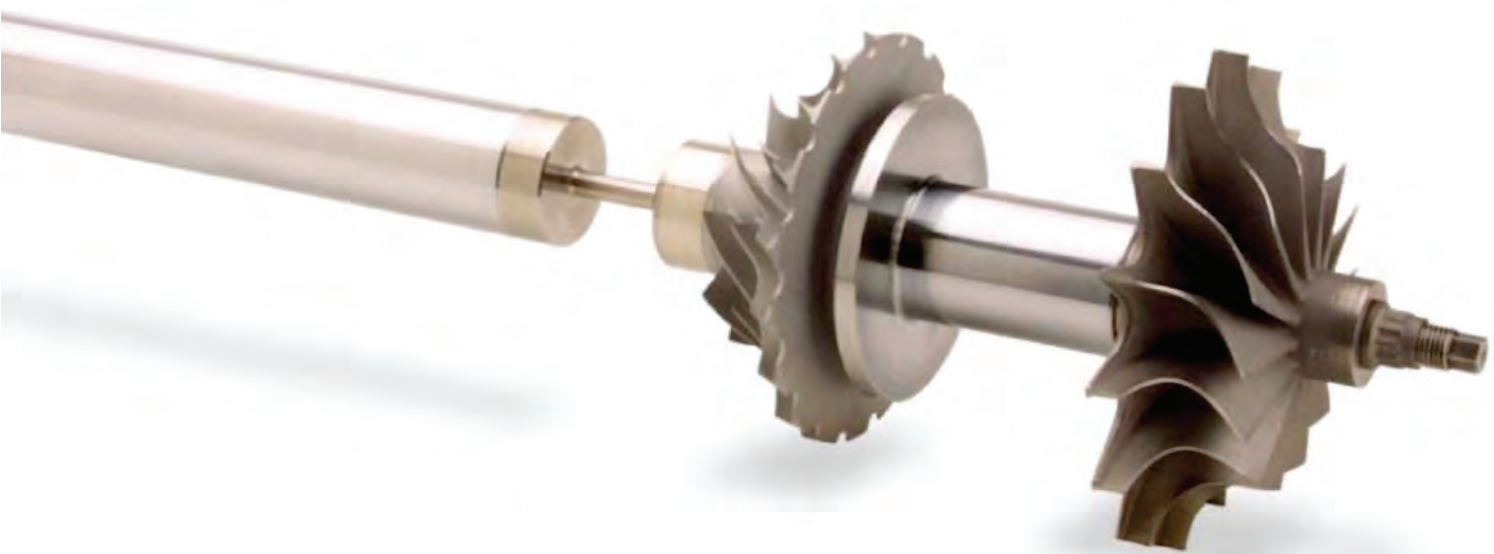
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TOYS, TENDERS & THE BRIDGE

Issues raised by increasing demand for these valuable accessories, plus captains' views on current bridge technology.

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The Microturbine Generator Arrives



New firm MME has entered the superyacht power market with a microturbine generator system offering new-to-yachting technology combining silence and ease of use. A year into prototype testing aboard the Royal Huisman schooner *Lethantia*, **Don Hoyt Gorman** reports on this innovative offering for on-board power.

Siegfried Steiner is a determined man. One day recently, he flew me – piloting the jet himself – to his yacht, *Lethantia*, the 44m Royal Huisman formerly known as *Borkumriff III*. Steiner had acquired the schooner in 2007. “I couldn’t afford her, but I had to have her,” he said, as we approached Marina Izola in Slovenia, where she has a permanent berth. “I’ve sailed since I was a boy, and this yacht is just perfect for me.”

“I wake up to a beautiful morning, and want to go for a swim,” he said, “but after a night of running the generators, which are a bit noisy, there’s this terrible ring of oil around the boat.”

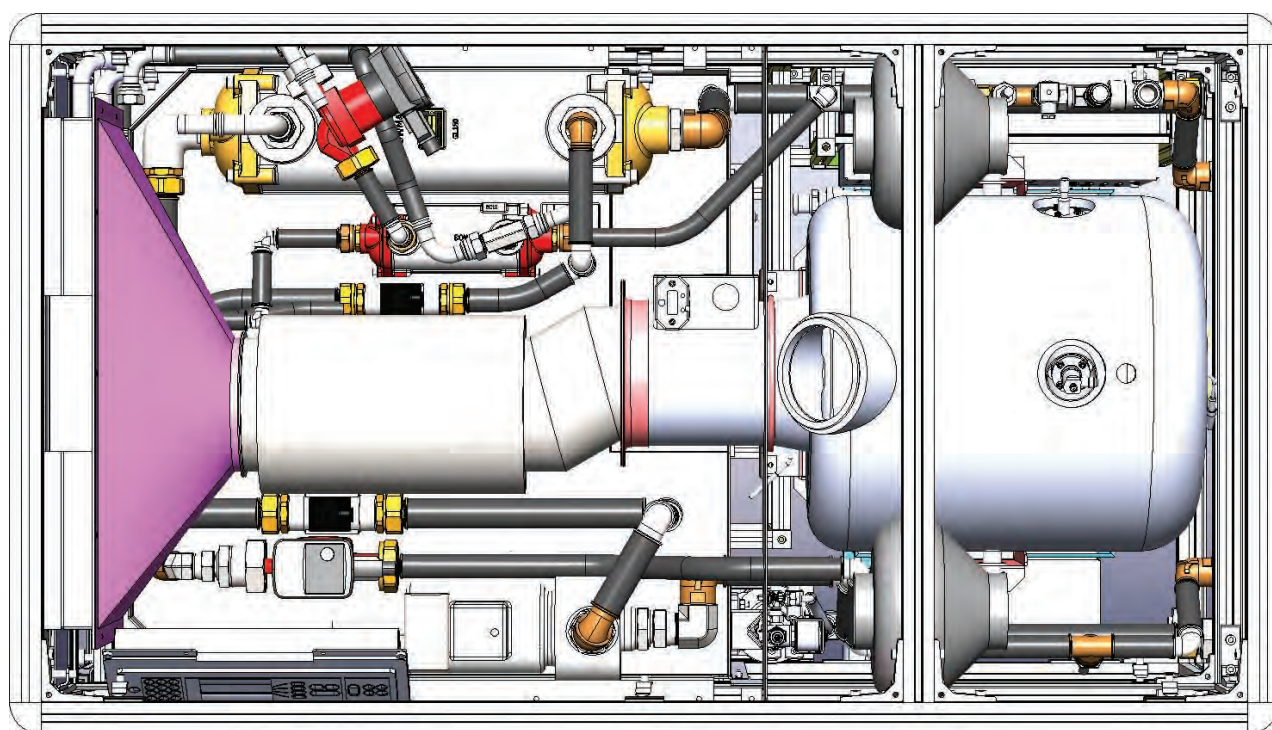
Perfect except for the annoyance he faced when he ran the generators. Steiner fixated on the issue of the noise and the occasional thin but noticeable slick of oil around the yacht after a night on anchor in a calm bay. “I wake up to a beautiful morning, and want to go for a swim,” he said, “but after a night of running the generators, which are a bit noisy, there’s this terrible ring of oil around the boat.” He speaks like a man addressing a taboo. “How is this possible today? I have to put up with this tractor rumbling inside my boat all night, and when I wake up, it’s ruined the water for my morning swim. No,” he said with gumption, “this is no good. So I found a solution.”

Rather than change the oil filters and invest in some earplugs, Steiner found and subsequently modified a piece of Californian engineering that has been hiding in plain sight for years. That he has now applied his technological and sales acumen to persuading the superyacht market that microturbine generators are the future of on-board power may be a game-changing challenge for the superyacht genset market worldwide.

Almost all marine vessels have their auxiliary power supplied by diesel generators, technology that has worked effectively for over 100 years. They’re proven, reliable and relatively cheap to buy, fuel and maintain. They are sold by the biggest names in the industry: Caterpillar, Kilo-Pak, Kohler, Mercedes, MTU, Northern Lights, Cummins Onan and others. There have been recent innovations like variable-speed options, which can cycle up or down to set RPMs to provide staged power delivery. New enclosures isolate the sound and vibration to a high degree, and efficiencies have consistently been upgraded. Most superyachts carry at least two generators; larger yachts can carry as many as six. Considering that there are 4,750 superyachts afloat and another 366 in build, diesel gensets are a huge business.

OPENING PAGE: CAPSTONE TURBINE CORPORATION’S PATENTED MICROTURBINE WITH AIR BEARING.

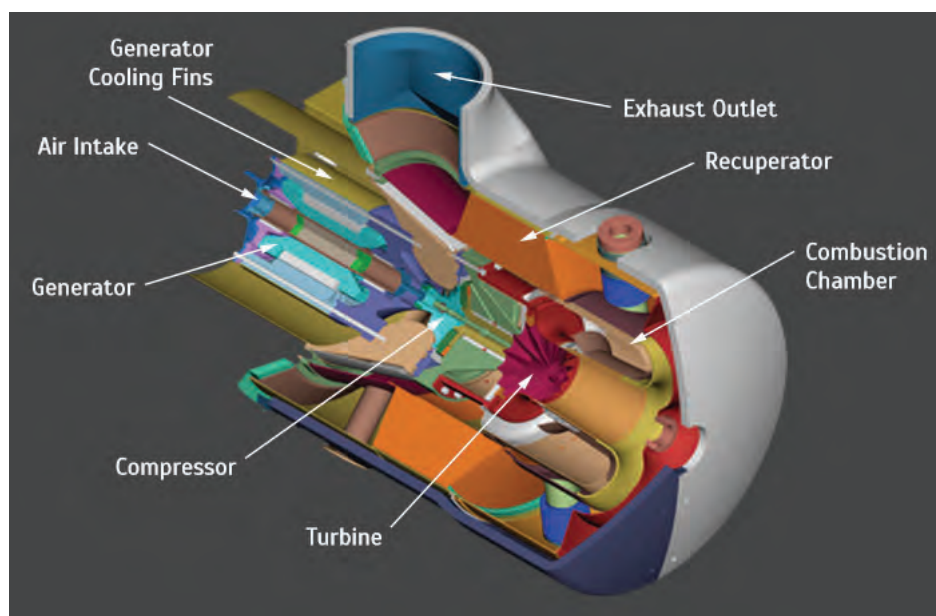
BELOW: TOP-DOWN VIEW OF THE MME 30KW MICROTURBINE ARRANGEMENT, 162 X 92CM (108.5CM HEIGHT).



As an alternative to traditional gensets, gas turbines first appeared at sea in 1947 for use in propulsion; since then they have been used mainly for naval and cruise ship applications, particularly in combination with other gas turbines or diesels. Turbine generators have been used as power units for decades as emergency or standby units ashore. They're more expensive than traditional diesel gensets, but are known to be highly reliable and they'll run on basically any liquid that burns – from (bio) diesel to liquefied petroleum gas (LPG). So far, though, the marine diesel market has remained steadfastly faithful to traditional gensets.

As a pilot, Steiner already knew about the small, light gas turbines that provide electrical power aboard aircraft as auxiliary power units. When he began researching power generation options, it occurred to him that similar technology could work at sea as well, and he quickly came across the leading manufacturer of microturbines in the world, the Californian firm Capstone Turbine Corp.

Founded in 1988 and headquartered near Los Angeles, Capstone is one of those impressive American companies that benefits from the pool of capital and talent that seems so profligate in the sunny state. A member of the US Environmental Protection Agency's Combined Heat and Power Partnership, which is committed to improving the efficiency of energy infrastructures and reducing environmental pollutants, Capstone was established to invent and sell better and smaller turbines. Using CFD and finite element analysis, along with material advances, Capstone engineers achieved higher compression ratios and temperatures, more efficient combustion, better cooling of engine parts and reduced emissions. The company's patented air bearings, which can withstand over 100,000 start/stop cycles, were developed in the 1990s. More



DETAIL OF THE CAPSTONE MICROTURBINE COMPONENTS.

recent advances in electronics and power-switching technology were the final piece of the puzzle enabling Capstone to deliver commercially viable, innovation-award-winning microturbines, which have, so far, logged millions of documented runtime operating hours.

As Steiner treated me to lunch aboard *Lethantia* in the quiet pre-season marina, he compelled me to join him in his eureka moment. "It seemed so obvious to me that these air-bearing microturbines by Capstone were the ideal systems to replace the traditional diesel generators on board *Lethantia*," Steiner said. "And, of course, I asked myself why no one else had seen this opportunity when it seemed so obvious to me."

Steiner Films, the business which he started in 1968 in Munich as a boutique, high-end film and video production house, may seem to be a simple film production company, but in fact is a hothouse of technological wizardry that brought Steiner himself both industry awards and significant wealth. Steiner focused on producing and displaying films for his clients by staying at the absolute bleeding edge of what was technically possible. Steiner is perhaps the greatest expert on disruptive technology that has fundamentally underpinned the evolution of the moving image over the past 40 years. Steiner Films pioneered the use of state-of-the-art equipment like Sony's HD video (in the 1980s), and gyro-

"With this microturbine, you can take it apart and plug it back together in a different arrangement. It makes it very easy to customise the installation."



ABOVE: SIEGFRIED STEINER'S 44M ROYAL-HUISMAN-BUILT *LETHANTIA*.

Once the genny was off, I heard nothing but the slap of harbour water against the hull, even though I was standing two metres from the engine room door.

stabilised helicopter mounts and 3D cameras for film and television. It's this technical focus that won him contracts to shoot commercials for top-shelf German and American clients, presenting sophisticated ideas in an attractive and informative style for the likes of BMW and Mercedes.

As he began to spend more time with his yacht, Steiner focused his considerable instinct for game-changing technology and his inventor's vision on his generator problem, and ordered a 30kW Capstone microturbine. "Right away, the benefits appeared obvious," Steiner said, as we opened the enclosure box on his first microturbine installation. He rattled off the systems's stats like a keen mechanic: "These are patented air bearings, so there's no oil used at all. It burns fuel incredibly efficiently: the exhaust emissions meet all emissions targets worldwide. Capstone rates its 30kW exhaust below 1.18g of NOx per kWh, well below the 2.4g/kWh required by IMO Tier III."

Steiner received the original unit, along with the CAD designs for the standard Capstone arrangement of components within the enclosure, but wanted to fit the system into the

existing Royal Huisman enclosure in the engine room that features nice teak touches. With a bit of tweaking to the arrangement, Steiner and his engineering team were able to get the turbine to fit the space required. "You can't disassemble a normal diesel generator and adjust the arrangement of the components," Steiner said. "With this microturbine, you can take it apart and plug it back together in a different arrangement. It makes it very easy to customise the installation." They pulled out the old port genset and brought the new system in through the engine room door.

Standing in the engine room with him, I wasn't entirely prepared for how quiet and smooth the machine was. I took a step outside the engine room and closed the door. I asked for the main genny to be turned off and the turbine to cycle up. Once the genny was off, I heard nothing but the slap of harbour water against the hull, even though I was standing only two metres from the engine room door. I did the same test in the owner's stateroom, which abuts the engine room. Inside, the turbine had taken five minutes to come online as it first charged the battery bank that Steiner uses for low-level house power at night. However, once online and

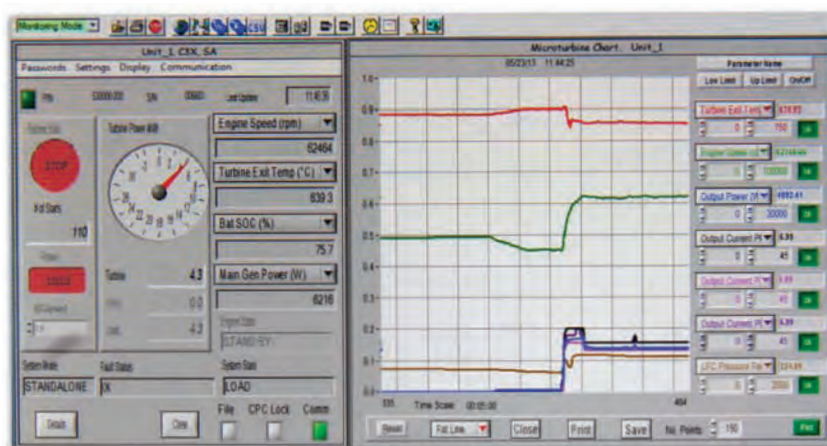
taking a load, it cycled up and down instantly as we asked for systems to be switched on and off. I followed all the internal systems on Steiner's iPhone.

Next, he plans to pull out the starboard diesel generator and install an upgraded version of the 30kW model with lessons learned from the prototype. "We'll add in a ventilator to aid in the exhaust, rearrange the components within the enclosure to make it even easier to access, and continue to upgrade the electronics."

There are a few things that need to be addressed before one would install one of these turbines. They need a lot of air, both for the turbine itself and to cool the electronics. Steiner informed me that Capstone has developed and is about to begin offering water-cooled electronic components with the turbines, which would ease the air-cooling load in the engine room. Steiner, perhaps not surprisingly, is also looking at retaining the waste heat from the turbines as part of a fresh-water heat exchange system. It's clear Steiner knows he's struck upon a rich vein of potential, both as a personal engineering project to bring the future into yachting and also as a business. His forthright enthusiasm is infectious.

At first, it wasn't easy for Steiner to convince Capstone that he had found a perfect match between their technology and a market in need. In fact, at first, he was largely ignored, but after he'd modified and installed their system, Steiner invited Capstone's people to see what he'd done, and they finally understood it. "It wasn't until after Mr Steiner had installed the microturbine that we really became involved," says Sven Fransen, business development director for marine and LNG at Capstone. "It was all his initiative. He has a very technically capable team around him, so he was able to do what was needed to achieve the results we're seeing today."

Even while the first prototype system was still undergoing its first year of in-water use aboard *Lethantia*, Steiner saw the commercial potential of the system and established Microturbine



THE TURBINE'S MOBILE MONITOR APP WHILE CYCLING UP.

Marine Energy (MME) to act as the marine specialists for Capstone's technology. MME now has exclusive worldwide rights for the marine market.

"Sometimes, ideas come from people who see the possibilities and can create a completely new business," Fransen said. "Although we'd discussed entering the marine market, we had other priorities. The increased stringency of environmental regulations has made our technology more attractive to the marine market, and so it was really a matter of timing and finding the right partner."

In line with Steiner's philosophy, all of the component parts MME uses for the system are sourced for quality: the sensors, pumps, enclosure materials, wiring and more are all selected for the calibre of construction and reliability. MME has enlarged the air-intake filters, which for Capstone's land use are rated for 8,000 hours. In the relatively dust-free environment at sea, Steiner expects theirs to last twice as long.

Capstone confirmed that they would honour the warranty for their part of the product, while MME will offer its own matching warranty for the electronic components. Capstone engineers will approve MME's design for the final package, and MME will be authorised to forward the standard warranty. "MME is not actually modifying Capstone's product: MME is taking the basic

"It's the comfort the owners will gain that closes the deal. You hear nothing when you sleep and there will never be a slick of oil around your yacht."

SIEGFRIED STEINER





INSTALLED ON BOARD *LETHANTIA*

Capstone components and putting them in a different enclosure,” Steiner confirmed. “We just make sure that airflow and cooling meet our requirements. With this system, we can offer a five-year warranty without any problem.”

Steiner says MME will build these systems in series: as of writing eight more 30kW and two 65kW units have been ordered from Capstone to begin preparation for sale to the superyacht market from their workshop in Munich. As awareness picks up, Steiner hopes to hear from yards and

project managers who might consider the units for diesel-electric and hybrid power use as well. The availability of a light, compact and low power microturbine for marine applications, one expects, should substantially widen the possibilities for hybrid power superyacht projects.

Steiner is calmly planning his approach to the superyacht market. “We’ll write a letter to all of the technical directors of the shipyards, telling them the story of what we’ve done here on *Lethantia*,” Steiner explained. “For us, it’s easy to say, ‘We know it’s working. After one year of running the prototype aboard, we know this is the perfect system. We have the contract with Capstone. So you can go with MME technology, or you can stay behind.’

“The argument for most yacht owners is not going to be about fuel consumption, and they’re not the ones who are really going to be persuaded by an easier maintenance schedule. What they’ll be sold on is that they are silent and clean. They’ll be attracted by the newest, best technology, and be aware of the benefits of the clean exhaust, but it’s the comfort they’ll gain that closes the deal. You hear

PERFORMANCE DATA

Performance Rating	Model C30	Model C65
Application area	Superyachts above 30 meter S/Y and M/Y	Superyachts above 30 meter S/Y and M/Y
Dimensions L x B x H	1620x920x1085 mm (63.8x36.2x42.7 inch)	2080x1070x1085 mm (81.9x41.2x42.7 inch)
Fuel consumption full load*	Diesel 11 liter linear	Diesel 21 liter linear
Power output kW*	29.0 (+0/-1) kW	64.0 (+0/-1) kW
Exhaust temperature	60° C / 140° F	60° C / 140° F
Exhaust heat energy	35 kW	45 kW
Exhaust emissions max.	1,18g/kWh NOx / 0,18/g/kWh CO	1,18g/kWh NOx / 0,18/g/kWh CO
Nominal voltage operating range	150–480 VAC, 3-Phase 150 to 700 VDC	150–480 VAC, 3-Phase 200 to 700 VDC
Nominal frequency operating range	10 Hz / 60 Hz	10 Hz / 60 Hz
Maximum output current	46A, stand-alone operation, with linear load	100A, stand-alone operation, with linear load
Operating temperature	-20 to 50°C (-4 to 122°F)	-20 to 50°C (-4 to 122°F)
Noise level	55 dB (A) at 2m	55 dB (A) at 2m
Unit dry kg/p	700 kg (1400p)	900 kg (1800p)
Remote control	yes	yes

*ISO conditions | ** standard fuel quality

nothing when you sleep and there will never be a slick of oil around your yacht."

As with any new technology, application will only really occur after a thorough assessment and demonstration to the market. "What we need is the refit yards and the new build yards to see and understand how this technology works," Steiner agreed. "What we're working on for the next model is designing the components in three parts: the hot section, the electronics section and the heat exchanger section. We're building it with a modular design so the yards can simply install, attach and test. No matter what diesel generator you have, you're not able to disconnect or detach components and put them back together again in the engine room – but with this turbine, you can." Steiner is currently pricing MME microturbines at €130,000 for the 30kW and €200,000 for the 65kW

"In 10 years time, no one will be buying piston-driven diesel generators. That technology is about to be overtaken."

unit. "With the increased investment upfront for this system, we expect owners will recoup the cost within two years, based on reduced fuel use, elimination of the oil lubricant and the cost of filters. On diesel generators, you have to change the oil every 200 hours and it's a mess. We have a big engine room on *Lethantia*, and we have the pumps and suction system to do it right: she's a Royal Huisman, so it's really well done. But still, what a waste of money and time when you compare it to the microturbine. We've had them running side by side for a year. It's just absolutely not comparable."

Steiner is determined, but he's also patient. MME is not something he's poured his money into in hopes of getting rich – his film business has provided him both the time and the capital resources to get this right. Speaking with him, one grasps that Steiner wants to perfect this as a matter of inventor's pride. He's doing what he does best – showing people how technology works – and setting up for when demand picks up. He will not have a stand at this year's Monaco Yacht Show, but MME will be at Boot Düsseldorf and he hopes to be present at the Global Superyacht Forum in Amsterdam this November.

"It's going to take four or five years to get everything really right," he explained. "People have to talk, and the industry needs to see how these work. Right now, everyone is talking about variable-speed generators. But those are also variable-noise and vibration generators, which are actually even harder to sound-isolate because the materials are only rated for a certain frequency. So people who are interested need time to learn, to see and test and get the data and finally make a decision; but they will. In 10 years time, no one will be buying piston-driven diesel generators. That technology is about to be overtaken." ■

Images: courtesy of Siegfried Steiner

To comment on this article, email issue146@superyachtreport.com with subject: The Microturbine Generator Arrives

MARINE MICROTURBINES CLASSIFICATION SOCIETY: AMERICAN BUREAU OF SHIPPING

The American Bureau of Shipping (ABS)'s experience with gas turbines on vessels and in other marine applications dates back to the late 1980s. Through the years, ABS has seen numerous gas turbines installed on ABS classed vessels, but most have involved gas turbines that were larger than the 500kW power output typically considered to be the upper power limit for microturbines.

It is recognised that microturbines offer a number of unique advantages such as their compact size, a limited number of moving parts and the ability to burn a variety of fuels. It also is noted that some units incorporate innovative waste-heat-recovery arrangements and provide for reduced emissions. So when considering the momentum in the marine industry to utilise efficient, lower-weight sources of power, we certainly expect to see more applications of microturbines on ABS classed vessels, including yachts, in the future.

For any installation of a turbine, including a microturbine, with a rating of 100kW or greater, ABS would require the design of the unit to be reviewed by an ABS engineering office and to be surveyed at the shop during manufacturing and shop testing. The review and survey would verify proper engineering design and fabrication of the unit as well as the provisions for various required safety features such as over-speed protection, low lube oil pressure and loss of flame during operation. The unit would also be surveyed after installation on board. Microturbines rated under 100kW do not require engineering review or survey for manufacturing. However, such units would still need to incorporate various required safety features, which would be verified by the ABS surveyor at installation. Specific information about ABS requirements for gas turbines, including microturbines, can be found in Part 4, Chapter 2, Section 3 of the ABS Steel Vessel Rules, which can be downloaded free of charge from the ABS website, www.eagle.org.