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Siemens SIShip Eco Prop

Modular Hybrid Propulsion

By Tork Buckley

The first superyacht with hybrid propulsion was Ethereal, although Ferretti had slightly earlier launched a Mochi Craft Long Range 23-metre motoryacht with high efficiency hull, capable of short-range cruising under battery. Here our Editor Tork Buckley looks at a modular solution to hybrid propulsion from Siemens, for motoryachts of around 45 metres. It suits larger sailing yachts too and uses automotive (relatively) off-the-shelf components.

Siemens are well known for power electronics, DE (Diesel Electric) and other propulsion systems for large vessels. Recalling the iconic Lürssen 96-metre Limitless, I remember seeing the original power electronics in that yacht which were Siemens-supply and pretty large. However, in the intervening 13 years the size of frequency drives shrank more quickly than did Alice when quaffing the “drink me” elixir.

They recently brought a new product to market along with system design and integration for builders of the smaller superyacht. SIShip is part acronym: Siemens Industry Suites Ship; it stands for all ship related systems. It’s a known Siemens product line offering DE systems from the 140KW to very, very large indeed. They supply large passenger vessels under the brand but go beyond to include total integrated electrical packages for cargo ships: machinery automation under IMAC (Intelligent automation technology for comprehensive control); ship-sized shaft generators BOOST; HTS (High Temperature Superconductor) solutions, pod propulsors SSP (Siemens-Schottel Propulsor) and even waste heat recovery for clean shipboard power WHRS (waste heat recovery system).

Continuing in a similar mode it’s hardly surprising they launched a new SIShip product: ECOPROP. The “eco” in the name offers a clue to the purpose – efficiency through use of DE or Hybrid DE. Christian Müller, Sales Manager at their Industry Solutions Division, told me one must not expect any DE or hybrid solution to be per se more efficient; in fact installed power needs to be 5–8% greater due to system losses. However, the real world situation and the real savings require that we look at how the system is used rather than simply its installed power.

There is of course also a price penalty; through life DE or
hybrid will be more operationally economical than conventional, so will save a commercial vessel operator money over time. On a superyacht operational costs will also be lower. But when compared with the extra capital investment it’s clear that this is not about saving money; it may be about having the most advanced high-tech solution, the minimum noise and vibration, visiting places off limits to internal combustion propulsion or to be environmentally responsible – or indeed all of these.

So far ECOPROP has found application on three vessels of very differing types. The first, already in operation, is a small inland ferry; this is a pure DE system driving four Schottel drive units. The second due for completion this year is the Wally 164 (50-metre) S/Y (below), using a pure DE system. And the latest is a full DE and battery hybrid – the 44-metre Kingship motoryacht Green Voyager (bottom), which is due to cut steel in the next few months. The ECOPROP system makes extensive use of off-the-shelf components.

Below: Due for completion this year, the Wally 164 (50-metre) S/Y
Bottom: The 44-metre Kingship motoryacht Green Voyager, due to cut steel in the next few months.

These are the E motor/generators and the inverter packs. The invertors are 495 x 415 x 180mm and 25kg, the 200 kW motor is 560 x 310mm square at 180kg; the 140kW is 65mm smaller in width and height and 60kg lighter.
Key to the high power density and small size is the fluid cooling. Invertors are mounted in a rack and the E-machines are fed a water glycol solution which is in turn passed through a raw water cooled heat exchanger. Their operating temperature on a yacht is 50°C, but in their original vehicle application they run at 70°C, showing a significant margin is available. However, the hotter they run the less power is available. The original use of these was mainly on hybrid buses using gasoline, diesel or fuel cells with batteries; one other bus used batteries alone with inductive charging. The system was also used on a Purolator delivery truck and some sub 20-metre DE motoryachts.

As mentioned above the system can be pure DE with one or two E-motors (pictured opposite) per shaft as on the Wally 164 yacht and even one or two per generator. But the most efficient use for a motoryacht is full hybrid DE. This is the system on the Green Voyager. The yacht is designed to have 16% lower fuel burn for propulsion and uses 20% less hotel power. This is achieved through clever system design, careful insulation and energy use control. However, just as on Ethereal it’s vital to make sure every kW generated from every litre of diesel is used or stored. It’s impossible to reach 100% but the aiming for it underpins the whole raison d’etre of a low-impact yacht.

One major difference between Ethereal and the Green Voyager is the R & D spend; Ethereal was first and development was expensive in time and money. Today with the Siemens modular systems at least the power and propulsion supply system requires no R & D. That has already been done for the automotive application so ECOPROP comes to yachting “free”. Of source Siemens have to deliver significant system design engineering and integration along with parameterisation of the PMS (Power Management System).

The Green Voyager shaft line uses a specially modified ZF gearbox (top image) onto which a Siemens electric machine is attached. There are two gensets also coupled to Siemens machines. There is one further machine attached to a conventional mechanical bowthruster gearbox. At the heart of the system is a DC 750 VDC bus feeding invertors, all controlled through CANBus by the PMS (second image). In this it strongly resembles two DE systems we recently found out about; EMS’s in issue 111, on page 41, and PCS Global Automation’s, which was presented at the Global Superyacht Forum 2009.

The E-motors on the thruster, attached to the diesel gensets are single purpose: turning the thruster propeller in the former and generating VDC in the latter case. The two on the gearbox are dual purpose: taking hotel power from the mains as the diesels propel the vessel; or actually turning the shafts with the mains off and declutched. Three of the various modes of propulsion and powering are shown here (third and fourth images).

There is a battery bank of some 400Kwh (again like Ethereal). These LMFP (Lithium Iron Magnesium Phosphate) batteries occupy around one cubic metre (just under one tonne and at today’s prices 125,000 Euros) per 100Kw hour. Siemens work with a number of suppliers, one of whom is Valence, a US company whose batteries are (in a case of coals to Newcastle) made in China, the source of the most advanced battery technology today (bottom image on previous page). They need to be housed in a space below 50°C (being even cooler gives more power and longer life) but since the form of the batteries can be customised it’s quite easy to fit them into irregular spaces.

Top to bottom: specially modified ZF gearbox; DC 750 VDC bus feeding invertors; various modes of propulsion and powering; and LMFP (Lithium Iron Magnesium Phosphate) batteries.
This set-up offers the PMS a wide diversity of ways to provide power for any given scenario. Christian even commented that transient load surges – when on genset or shaft generators – could be temporarily carried by batteries without the need to fire up a genset. At anchor at night it’s intended that the yacht will run hotel loads solely on battery. Slow running silently on battery alone is possible for a short time with battery and genset DE, for example dinner cruising is possible for around 15 hours at 8 knots.

The ECOPROP is a fairly niche solution – ideal for a smaller motoryachts like the 44-metre Kingship or larger sailing yachts like the 50-metre Wally.

Siemens’ job is to work with the yard and determine how to program all these demands within the PMS system. The answers will include automatic, manual and emergency override sequences. Their scope of supply includes design engineering and commissioning, but they do not supply main or genset diesels. Siemens do have some requirements of the diesel prime movers beyond the obvious of being big enough.

The genset motors need not be conventional heavyweight marine diesels; in fact the gensets here will be small lightweight truck derived units that can be easily fitted with standard exhaust after treatment units. The diesels must also be able to send out speed data and be electronically controllable; so they need electronic fuel racks. Siemens need the power curves to tailor machinery control to provide maximum efficiency and minimum fuel burn. The E machines have an upper limit of 3,000rpm so if the generator prime mover revs above that a reduction, but non-reversing, gearbox is needed. Obviously a generator gearbox is undesirable for a variety of reasons – weight and cost being two – so choosing a motor with lower rpm is a better option.

These are variable speed gensets. I recall Jan Bokxem of Royal Huisman telling me such a solution was investigated for Ethereal. They were contemplating marinised VW truck engines for a vari-speed genset. However, he added at the time the concept was just a bit too unproven and high risk. Now only a few years later it’s effectively off the shelf. The gensets run between 1,200 and 2,400rpm to ensure they are as fuel-efficient as they can be.

What if one needs a 100kW genset? The answer is to use a 140kW E machine on a smaller diesel. One overall system so with the yard they coordinate supply on board and the necessary drawings.

The ECOPROP is a fairly niche solution – ideal for a smaller motoryachts like the 44-metre Kingship or larger sailing yachts like the 50-metre Wally. The advantage is size and weight. The limitation of course is 200kW motor limit. One could, I suppose, have up to four on one gearbox; however, the engineering complications for a maximum of 800kW would likely not be justified. Once you reach larger LOAs and power demands standard modern DE solutions are more valid such as PCS, EMS and indeed Siemens’ SIShip larger maritime DE kit.

Kingship looked at three suppliers for propulsion. Amongst other considerations, the reason ECOPROP was chosen over the other two was that the equipment would fit into an engine room already crowded with RINA Green Plus compliant and zero discharge equipment. Go up to even a 55-metre motoryacht and ECOPROP would not be as suitable as a small ship DE system. So it is an interesting, size specific and off-the-peg solution for the mid-sized yacht that wishes to pursue an energy efficient route. Green Voyager will undoubtedly be only the first of many since the sizes around 40m are still the biggest part of the superyacht market. Indeed another Chinese builder, MCC, is believed to be looking at ECOPROP for future models in their 45-metre Marco Polo series.

Images: courtesy of Tork Buckley, Kingship, Siemens & Wally

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