The Li-ion share

Li-ion technology is an ideal partner for new-generation marine propulsion systems, according to Yannick Chartier, **Saft Batteries**' space, defence and marine business development specialist.

Environmental considerations are back at the top of the shipping industry's agenda, with the most recent amendments to the United Nations International Maritime Organisation's MARPOL regulations coming into force in January this year.

The hope is that new limits under MARPOL will reduce greenhouse gas emissions from ships by 30% by 2030, a cut designed to curb the growth of the industry's share of global emissions, which would otherwise rise to 18%.

A very attractive option is to adopt full or hybrid electric architecture for new ships, where advanced battery technologies now offer interesting possibilities for the creation of highly efficient and cost-effective marine propulsion and auxiliary systems.

Of the battery technologies available, lithium-ion (Li-ion) shows particular promise for demanding marine applications. In fact, Li-ion batteries are already well-established in a range of industrial applications, ranging from satellites to telecoms backup power and energy storage systems supporting renewable energy installations, where they demonstrate high performance, long calendar and cycle life, zero maintenance and a low total cost of ownership, all in a compact, lightweight package.

This technology, which is scalable to meet energy and power demands, holds great promise for hybrid propulsion systems. In these machines, batteries work in conjunction with diesel or gas turbines, generators and electric motors.

And there are a number of marine sectors in which hybrid systems might be applied.

Workboats

Typically, workboats spend most of their time at sea manoeuvring into position and only operate at full power for brief periods. Hybrid power can offer improvements in fuel efficiency and CO_2 savings because, rather than sizing a diesel engine for peak power, it can be set at a more economical size for average power. When full power is required, stored energy from the batteries comes into play.

The battery system can operate in parallel for low power operation, while providing the necessary boost to the single diesel generator for infrequent high-power operations.

There is also scope for load-levelling applications, similar to those adopted in diesel-electric trains, in which the generator is maintained at a constant load (typically 80% of capacity), therefore saving fuel, cutting CO_2 emissions and reducing maintenance overheads.

Passenger vessels

Ships such as ferries and shuttles can also benefit from hybrid systems. Spending much of their operational life in harbour for docking and undocking, the ability to switch to clean electric power can enable considerable savings on CO_2 emissions, helping port authorities meet their environmental targets.

A side benefit of quiet

Hybrid power can offer workboats improvements in fuel efficiency and CO_2 savings.

operation is that it can reduce the impact on the local community, while ship operators will feel the benefits of fuel savings and reduced maintenance over the lifetime of the batteries.

Leisure craft

Leisure boats, particularly high-end vessels such as mega-yachts, could switch to battery power when entering port. This would enable silent, low-speed running, and help to meet the growing demand from port authorities to reduce CO_2 emissions.

Furthermore, when moored, batteries can support hotel loads until making a connection with the onshore power supply without running the engine, keeping emissions down as well as cutting vibration from engines, which also enhances a vessel's comfort – an important consideration for leisure vessels.

Saft's 54kWh Li-ion batteries show particular promise for demanding marine applications.

Sizing a battery system

A theoretical scheme has been developed for a passenger ferry with hybrid propulsion and energy storage. The model is based on a typical 15,000t ferry, carrying 300 cars and 1,000 passengers, for short-distance operations that require frequent rotations in and out of harbour.

Main propulsion is delivered mechanically by a diesel engine twinned with a variable pitch propeller, together with diesel-electric pods that offer improved manoeuvrability, greater energy efficiency and lower noise. Hotel loads include general ship services, such as lighting, ballast pumps and heating, ventilation, and air conditioning, as well as cargo and duty services such as pumps, winches and actuators.

Such a ferry would tend to have four modes of operation: open sea, when the Li-ion energy storage system is charged as the ferry runs on mechanical power from the genset; channelling and manoeuvring operations, when the vessel is propelled by the energy storage system, which also powers the hotel loads; docked in harbour, when hotel loads are supplied by a shore-to-ship cold ironing power connection or by the energy storage system; and night call, when cold ironing supplies residual hotel load and charges the energy storage system.

The hybrid system for this ferry would require a battery capable of delivering a peak power of 4.5MW and 1.75MWh of energy to achieve ten and five minutes each of channelling and manoeuvring operations at 1.5MW and 0.5MW, plus support for hotel loads, which demand around 2MW. Due to its compact, lightweight design, a Li-ion battery for this application would weigh less than 20t and take up around $10m^3$.

Ferry operations on the River Garonne

An important real-world example of a hybrid diesel-electric propulsion system is on two ferries operating on the River Garonne in Bordeaux.

Designed to carry around 200,000 passengers and their bicycles every year, each hybrid ferryboat is equipped with a 140kWh Saft battery system that supplies power for electric propulsion and auxiliary loads such as lighting and communications. The battery works in conjunction with the boats' diesel engines, storing power produced as well as providing additional propulsion when required.

The Li-ion batteries are charged overnight from the local grid and their excellent energy storage capability provides boats with six hours of autonomous, fully electric operation during the two busiest periods of the day – three hours in the morning and another three hours in the evening – helping to reduce fuel costs and emissions. ■

Further information
Saft
www.saftbatteries.com
yannick.chartier@saftbatteries.com