

# Developing LNG as a green ship fuel

The five LMG Marin-designed, LNG-fuelled, double-ended ferries serving Norway's coastal routes herald a new era of gas-powered ships

Norway's aspirations to reduce greenhouse gas emissions and utilise its abundant gas resources are driving the development of a coastal LNG distribution infrastructure and the introduction of new ship propulsion system technology. To date four offshore supply vessels, one prototype ferry and five newer passenger/vehicle ferries fuelled by LNG have been delivered for service in Norway and further, similar projects are taking shape.

Gas-powered vessels offer an 80 per cent reduction in nitrogen oxide (NOx) emissions and a 20 per cent cut in carbon dioxide (CO<sub>2</sub>) emissions compared to existing ships driven by conventional diesel engines. Also, gas-burning engines do not give rise to sulphur oxides (SOx) or particulate emissions.

The five new ferries are 129m-long, double-ended vessels operated by Fjord1 and built by the Aker Brattvaag yard to a design developed by the Bergen-based technical consultant LMG Marin. Three of the ferries run between Halhjem and Sandvikvåg at speeds up to 21 knots, joining sections of the E39 highway along the coast south of Bergen while the other two, with maximum service speeds of 17 knots, link Arsvågen and Mortavika in the Stavanger region. These routes are the second and third most intensively used ferry links in Norway in terms of passenger and vehicle numbers.

The Fjord1 ships are powered by Bergen lean-burn, spark ignition, gas engine generator sets from Rolls-Royce in what is the first marine application for this power plant. The innovative shipboard use of this gas-electric power train necessitated a redesign of the control system, a task carried out in parallel with the ship design work. The five vessels are the largest ferries in Norway and the fastest double-ended ferries in the world.

"The design of the Fjord1 ferries posed other challenges besides the propulsion system," points out Torbjørn Bringedal of LMG Marin. "The service speed requirement of 21 knots has never been provided before for a double-ended ferry such as this. The hull design was only finalised after extensive model testing at Marintek. The hull has



Each of the Fjord1 ferries stores its gas fuel in two LNG storage tanks

bulbous bows at each end and it was important to make both bow and stern bulbs work efficiently. Another constraint was the need to keep the vessel's weight as low as possible in order to ensure that the strict fuel consumption requirements placed on Fjord1 were met.

"At the start of this project the Norwegian Maritime Directorate (NMD) had only preliminary and very strict rules for gas-fuelled passenger ships," continues Mr Bringedal. "NMD, therefore, developed the final rules for such ships in parallel with our design work. More specifically, the rules are based on a risk analysis for gas-related systems, during the carrying out of which we worked closely with NMD to specify safe solutions in both the design and the rules."

The Fjord1 ferries went into service in early 2007 and experience to date has shown that the operator is able to operate the ferries within the fuel consumption estimates as originally calculated. Furthermore, the maximum speed that has been logged is 23.8 knots and Fjord1 reports that the loading and unloading of cars is proving to be a very efficient operation.

LMG Marin is currently working on the design of a series of three new LNG-fuelled double-ended ferries to go into operation on the Molde-Vestnes connection from 2010. These ferries, each with a 125-car capacity, will be built by the Remontowa shipyard in Poland and will also be operated by Fjord1. [LNG](#)