



## Rolls-Royce Bergen

# A SOLUTION FOR A ZERO EMISSIONS FUTURE IS ON THE HORIZON

The pace of change towards a zero emissions future needs to increase to meet the goals set forth in the Paris Agreement and to protect our planet from dramatic climate changes. So how can our reciprocating engines be part of the solution?

In Rolls-Royce Bergen we are committed to developing flexible and clean power solutions that will sustain and enable the energy transition.

The latest reports from DNV GL<sup>1</sup> and IEA<sup>2</sup> foresee a significant increase in the share of renewable energy sources, in particular solar PV and offshore and onshore wind, towards 2050. At the same time, a large amount of conventional coal fired power generation will retire. To improve energy efficiency, there will also be a shift towards electrification in general, with an immense increase of electric vehicles worldwide. With today's technologies, these measures may be our only way to pull the break of global warming and improve air quality. The demand for electricity is bound to remain high due to emerging economies and electrification, and intermittent renewable energy alone will struggle to deliver all the power that is needed.

Battery storage, demand side response, improvements in energy efficiency, and Power-to-X (synthetic fuels produced from renewable energy) are some of the many options we currently have available to support renewables in a low-carbon manner.

We listen to the experts, and according to DNV GL<sup>1</sup>, gas fired generation, as the cleanest fossil fuel, will continue to play an important role towards 2050. Natural gas fired reciprocating engines from Rolls-Royce Bergen are a clean, affordable and energy efficient alternative to fill the gap from coal fired generation. With heat recovery, the efficiency is beyond 93%, GHG emissions are low, and there are no emissions of particulate matter. The engines can run 24/7 to deliver baseload power, or they can kick in quickly whenever extra power is needed to stabilize the grid. Rolls-Royce Bergen was a pioneer in developing the modern lean-burn gas engine technology

which has been applied to several hundred engines to date, proving their reliability over millions of running hours. Technological improvements have been introduced consistently since the first gas engine was released to the market in 1991. In fact, this first gas engine is still in operation. A simple and robust design ensures high availability and efficiencies of up to 50% with single-stage turbocharging.

**To cater for future changes in fuel supply and stricter emission regulations, and to avoid stranded assets, it must be possible to convert gas engines to green fuels at a later stage. And that's when the built-in flexibility of our Rolls-Royce Bergen engines will come into play.**

#### Future proof power solutions

Rolls-Royce Bergen develops sustainable power solutions that enable the shift towards carbon neutrality. We are in the process of future proofing our engines by enhancing their flexibility so that they can run on various fuel types as the fuel availability landscape transitions towards carbon neutral fuels. The modular architecture of the engines allows for easy adaptations of minor and major reconfigurations of the engine's combustion system. We are committed to give our customers across the power generation and maritime markets the assurance they need to proceed with the investments. Our engines typically operate between 20 to 25 years, and the modular architecture ensures that a gas or liquid fuel engine purchased today, will be just as relevant also in one or two decades.

#### Hydrogen based power generation

The European Union considers hydrogen as essential to reduce emissions from industries, transport, power generation and buildings, and believes in its function as a vector for renewable energy storage<sup>(2)</sup>. Existing gas pipelines can be repurposed for the transport of hydrogen, and EU's strategy is to build a full hydrogen ecosystem in Europe. Rolls-Royce Bergen has tested gas engines with fuel gases containing up to 60% hydrogen. We are currently engaging in European projects studying the effects of blending hydrogen in the fuel gas of standard natural gas operated engines. Pilot tests will be run in our engine lab and on existing power plants. The re-configurability of the latest Bergen B36:45 gas engine series, allows for an evolution of the engines as requirements change. Starting out from the current natural gas engine, a certain amount of hydrogen admixture can be allowed without any changes to the engine. To increase the hydrogen admixture while maintaining the performance levels, the engine software must be tuned. Rolls-Royce is aiming to have a commercial retrofit solution that will accept a

Hydrogen content of up to 60%, and that can be developed to accept 100% for new engines to come. This engine solution will be equally suitable for maritime applications.

#### The maritime fuel of the future

Direct electrification through batteries is likely to become a good choice for short distances, such as for ferries and harbour tugs. For long haul transport however, ammonia is a good bet as the fuel of the future. It is a favorable fuel consisting of Nitrogen and Hydrogen only. Also, the existing large global production capacity will be scalable to the required volumes, with costs depending on future pricing of (green) hydrogen. Rolls-Royce is exploring several pathways towards ammonia fueled engines, and is collaborating with other industry partners to find the best overall system solution. Both Otto and Diesel-principle engines hold promise as ammonia burning engines. Rolls-Royce Bergen is working on systems for both types, ensuring that the engines are more fuel flexible going forward.

The diesel process is particularly robust towards fuel quality variation. Therefore, we are developing a highly flexible dual-fuel engine that can be rebuilt to burn ammonia, methanol, hydrogen and other synthetic fuels, in addition to being a host for hydrocarbons (gas, LPG etc). The project is a joint effort with other industry partners including relevant technical universities.

The programme opens for the possibility to develop retrofit solutions (conversion kits) for engines in operation. Successful conversion of the existing fleet will accelerate the overall transition to zero (carbon) emission fuels.

**Reach out to our experts in Rolls-Royce Bergen to discuss the best solution for your specific project.**

<sup>1</sup> DNV GL Maritime Forecast to 2050

<sup>2</sup> World Energy Outlook 2020

<sup>3</sup> [https://ec.europa.eu/energy/sites/ener/files/hydrogen\\_strategy.pdf](https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf)

# FUTURE PROOF

The fuel flexible Bergen  
B-series - part of the  
solution

