



**MACKENZIE
INDUSTRIES**

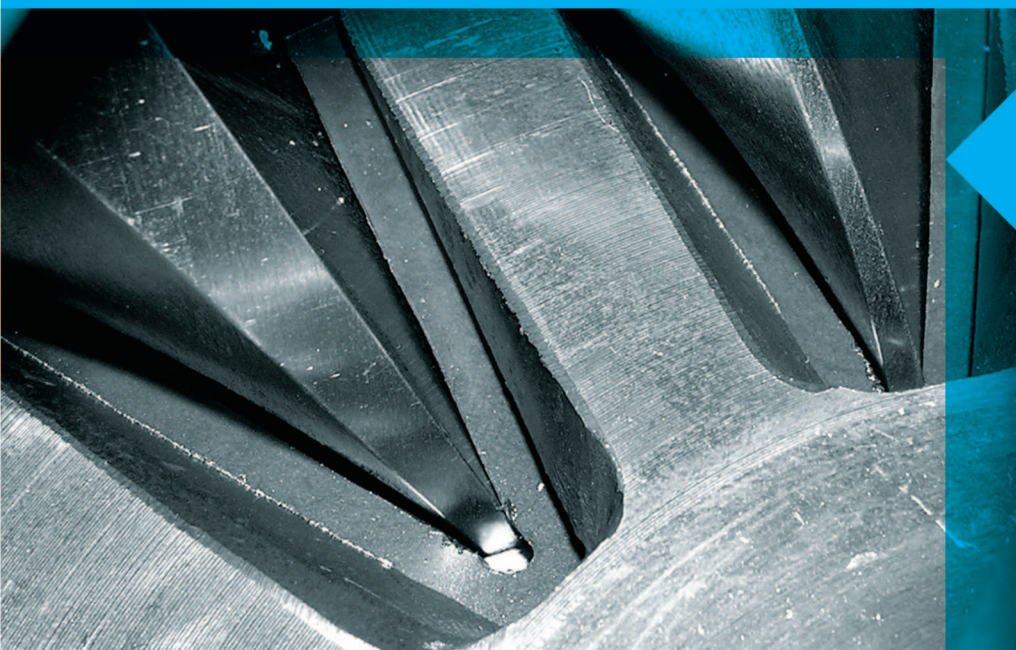
**TURN YOUR HEAT INTO ELECTRICITY
NO FUEL, ZERO EMISSION**

ORC Technology



E-RATIONAL
VALUE FOR HEAT

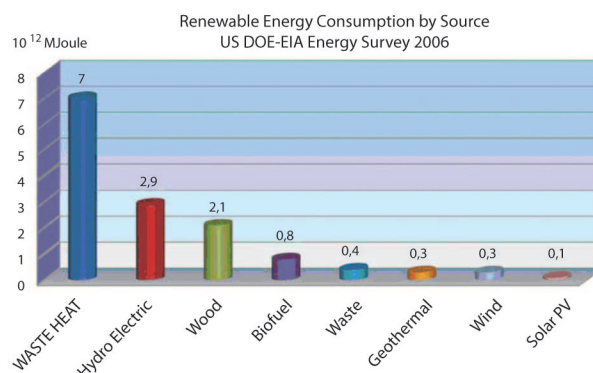
Today, industry remains primarily dependent on fossil fuel derived energy and as a result, subject to price volatility, questionable fuel reserves and geo-political influences. In view of this and increasing concern over the current and long-term effects of global warming, scientists and engineers have made significant advances in the field of alternative, clean energy technologies such as solar, wind and biofuels. In spite of these advances, it is evident that fossil fuels will remain the most important source of thermal energy to industry for the foreseeable future. For both economic and environmental reasons, it is therefore imperative that energy efficiency be maximised.



**maximum
availability**

Powered by waste

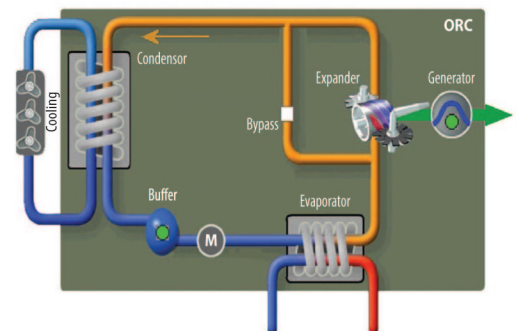
Although there have been great advances in energy optimisation, it is still recognised that there is a significant loss of energy in the form of industrial waste heat. This loss is estimated to be significantly greater than the energy generated through all alternative energy sources together. (Source: US DOE/EIA Energy Survey 2006).



E-RATIONAL ORC-Technology offers an effective and viable solution to recover and convert a part of this waste energy into electricity, which in turn is fed to the power grid, thereby reducing net emissions and fuel consumption, while offering the client an additional revenue opportunity.

Proven technology

The ORC technology or 'Organic Rankine



Cycle', named after the Scottish engineer William John Macquorn Rankine, is similar to the cycle used to drive a conventional steam turbine in which water is heated to produce steam, which due to an increase in pressure causes the turbine to rotate.

The ORC cycle however replaces water with an Organic Fluid, which is able to vaporise at a lower temperature than water. This permits the use of waste heat as a 'Clean Fuel' for power generation.

Ecological and financial advantage

E-RATIONAL ORC-Technology is able to recover and generate electrical energy from a broad range of thermal heat sources including: exhaust gasses from combustion systems and motors, industrial fluid streams and exothermic process etc. The electrical energy produced may then be used to compensate

the electrical energy consumed within the facility and or sold to the local grid. Should the initial fuel source be considered renewable, under current European Legislation it is also possible to earn green certificates and or sell the electrical energy at a premium tariff with an obvious positive effect on the return on investment of your project.

E-RATIONAL ORC-Technology offers an opportunity to improve the global efficiency of your installation while reducing your carbon footprint, as the technology generates zero emissions and represents no environmental disturbance.

It is therefore a discrete power supplier offering you immediate financial and significant environmental benefits.

ORC design

E-RATIONAL due to its extensive engineering and industrial expertise as a systems manufacturer for industry and in particular the automotive sector and through close cooperation with expert universities, is able to offer the highest standard in ORC-Technology at an unequalled price per produced kWe.

E-RATIONAL has designed its ORC technology to operate using recovered waste heat in a temperature range of between 80°C and 150°C and for a power range of 50 to 250 kWe at 400 VAC.

The systems have been conceived to be capable of operation in battery thereby enabling greater energy recovery, partial load efficiency and redundancy in the event of maintenance.

Furthermore, the systems are preconfigured and fully tested in our production facilities.

Standard components

During design, E-RATIONAL has used standard components employed in the automotive and aerospace sector that have been optimized and improved through internal expertise and extensive research, in order to guarantee reliability, performance and client satisfaction.

In this regard, the heart of the ORC system is the Z-screw expander, which in turn is connected directly to the asynchronous generator.

As a result expensive and potentially fragile components are avoided, such as fast rotating turbines and or transmission systems.

This guarantees the reliability of the ORC system and ensures low operational costs and a fast return on investment.

Extensive software control

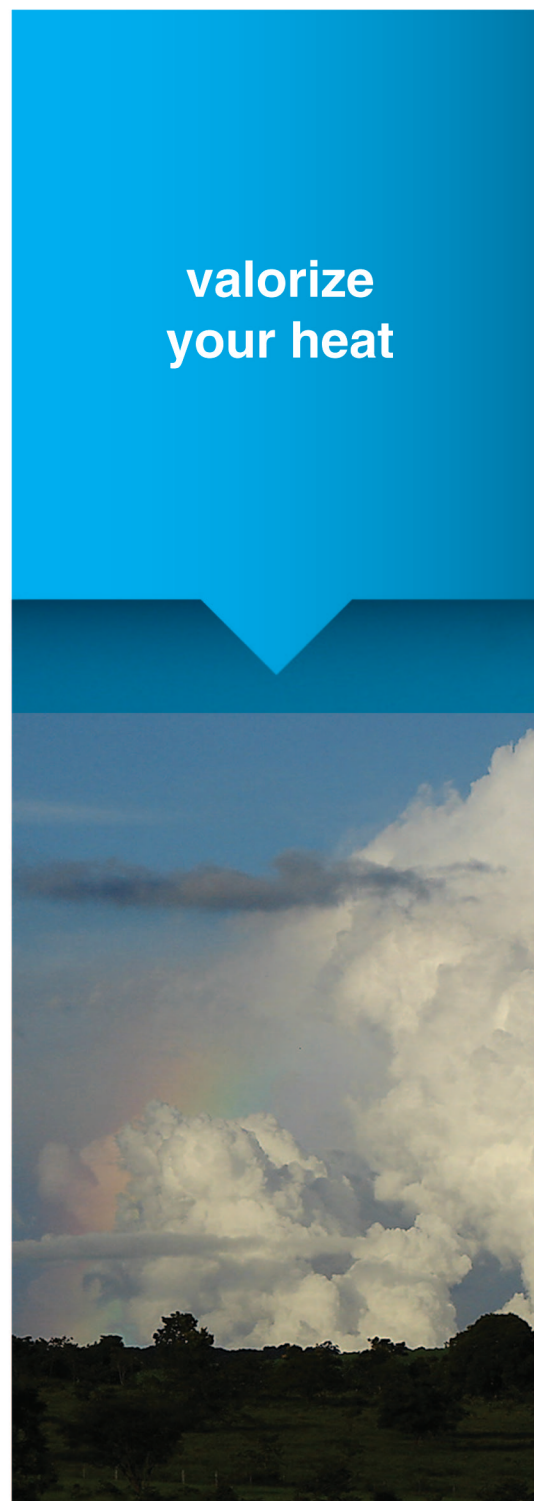
The ORC unit and all related systems including the connection to the power grid are controlled via a robust and user-friendly software interface. This enables simple and highly autonomous operation of the plant in addition to real time monitoring of energy generation and other key parameters.

Safe ORC fluid

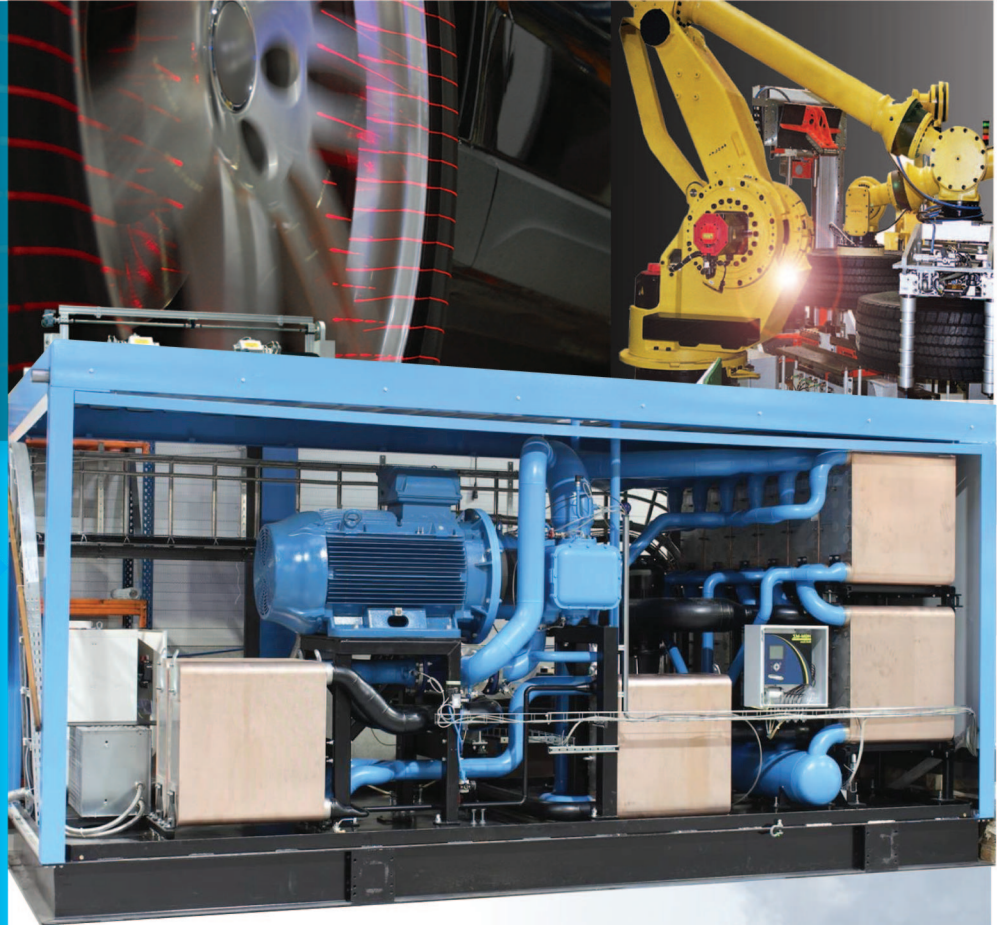
The ORC fluid used within the closed loop system is environmentally safe, inflammable and nontoxic. In the E-Rational units, it can be used in a temperature range of between 80°C and 150°C.



**valorize
your heat**



our
company



About Mackenzie Industries

Mackenzie Industries was formed in Year 2005 by a group of experienced boiler engineers together with **Wah Seong Group**. Mackenzie Industries is currently housed under the **Renewable Energy Division** of Wah Seong Group.

Mackenzie Industries is specialized in provision of steam and energy solution to various industries. Our expertise includes customized steam boiler firing biomass waste, oil, gas as well as waste heat firing in the case of industrial heat recovery steam generator (HRSG) and ORC (Organic Rankine Cycle) technology.

Together with our Principal, E-Rational from Belgium, we introduce the ORC technology to the market to assist our customer to make use of any low grade waste heat to generate power. Traditionally the low grade heat is discharge as a waste. Further attempt to recover this heat by conventional method is considered economically not feasible. However, this is possible with the ORC technology.

Artwork for Approval

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