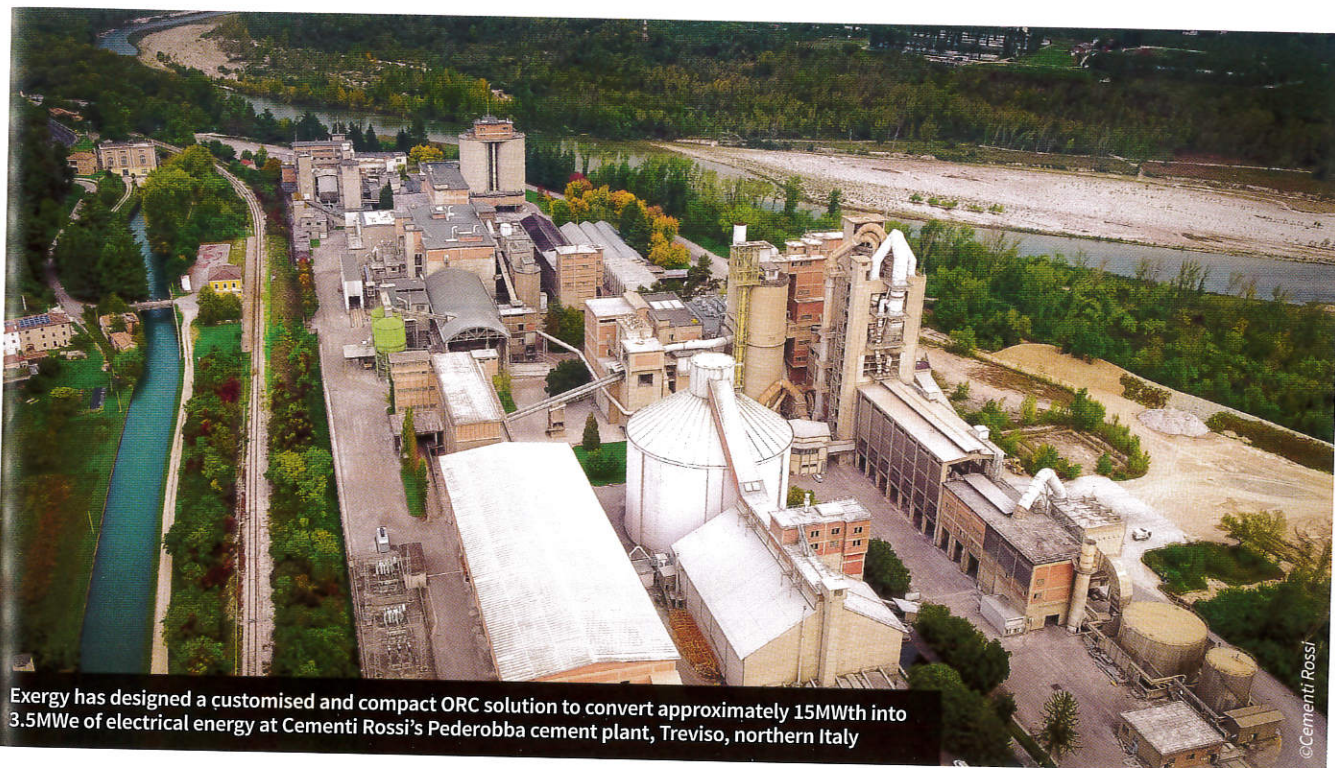


Cementi Rossi's ORC solution

Organic Rankine Cycle (ORC) technology for waste heat recovery is a widely-proven technology for cement factories. A new tailored, turnkey ORC unit for Italian producer Cementi Rossi will feed about 30 per cent of its Pederobba plant's needs, with higher efficiency, improved safety and lower environmental impact in mind.

■ by **Exergy, Italy**



Exergy has designed a customised and compact ORC solution to convert approximately 15MWth into 3.5MWe of electrical energy at Cementi Rossi's Pederobba cement plant, Treviso, northern Italy

According to the latest International Energy Agency (IEA) reports, due to rapidly-growing urbanisation and global population, cement demand is set to increase by between 12-23 per cent by 2050 (see Figure 1). As a result, CO₂ emissions will increase by about four per cent within

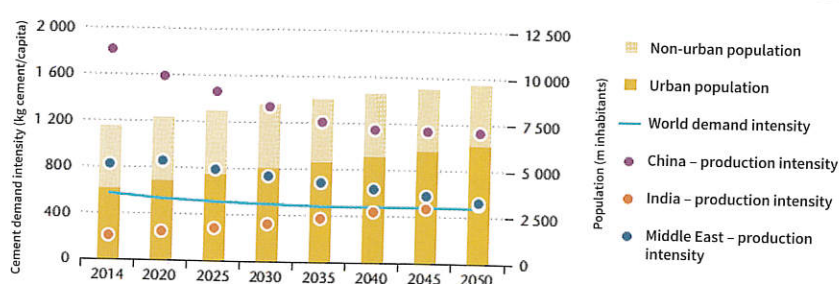
the same timeframe. Despite technological innovations, the cement sector is still the third-largest industrial energy consumer worldwide, responsible for seven per cent of global industrial energy use. Cement manufacturing also has the second-largest share of total direct industrial CO₂

emissions worldwide (IEA, Technology Roadmap – Low-Carbon Transition in the Cement Industry, 2018).

However, considerable progress has been made towards energy efficiency strategies and reducing CO₂ emissions in the cement sector in recent years. Switching to alternative fuels, reducing the clinker-to-cement ratio and integrating carbon capture into the production process are some of the main carbon mitigation levers that can support the sector's transition towards a more sustainable and efficient cement manufacturing process. But there is still a long road ahead: government policies do not keep pace with the sector's needs, and certain technological innovations still leave plant owners hanging in the balance between economical investment and efficiency results.

Among the various technological innovations, Organic Rankine Cycle

Figure 1: global cement demand intensity and population, and cement production intensity for selected regions



Note: Cement demand and production intensities displayed refer to the low-variability case.

Source: IEA Technology Roadmap – Low-Carbon Transition in the Cement industry (2018)

(ORC) technology has proven to be a valuable and effective solution to exploit preheater and clinker cooler exhaust gases. ORC technology allows the plant to produce electrical energy from a secondary resource, otherwise wasted, achieving better efficiencies even with low temperatures (from 90 °C up to 350 °C).

Moreover, the flexibility of this technology allows the systems to be located away from water sources, as it does not require water treatment and make up.

Cementi Rossi's turnkey WHR solution

Exergy SpA recently designed a tailored waste heat recovery (WHR) turnkey solution for Italian cement producer Cementi Rossi. The scope of the project includes erection, commissioning and start-up of the system.

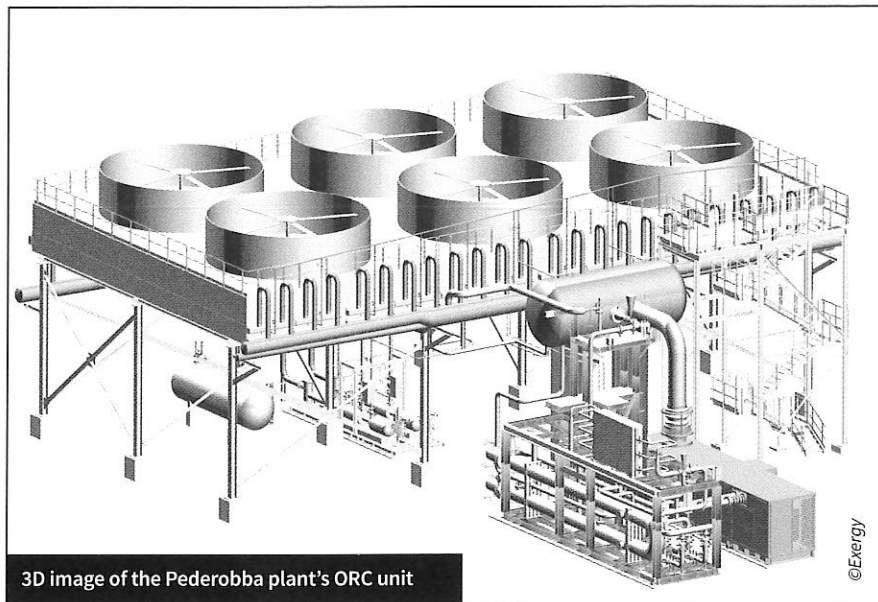
Cementi Rossi was willing to install a WHR unit at its Pederobba plant in Treviso, northern Italy, that could exploit the exhaust gases from the clinker cooler and the preheater, thus reducing electrical energy consumption. The challenge of this project was to overcome certain issues, namely a low-temperature available resource and space restrictions due to the surrounding area.

The solution

Exergy designed a customised and compact ORC solution to convert approximately 15MWth into 3.5MWe of electrical energy, guaranteeing high performances of the WHR ORC unit and short delivery times.

Exergy chose to use prefabricated materials to reduce delivery times and positively impact on the final cost of the complete unit. It also designed the unit to be preassembled on skids to reduce overall

"...the plant will save approximately 5400toe per year, thanks to a decrease in the use of fossil fuel-generated electricity, and about 17,000t of CO₂ by exploiting the exhaust gases coming from the clinker cooler."



delivery time from contract signature to commercial operation and avoid the risks of an erection fully executed on site. The use of prefabricated materials, preassembled on skids, allows Exergy to deliver the complete plant saving in about half the usual erection time.

The Pederobba WHR ORC unit area is about 35m long x 45m wide. Exergy managed to position all the main components of the plant in a compact solution comprising an air-cooled condensing system, radial outflow turbine (ROT), evaporator, generator, and lubrication and seal oil unit.

Optimising cycle design for improved efficiency and safety

Exergy's main challenge was to optimise the cycle design to enhance and increase efficiency with the available resource. Safety was another very important factor to be considered when designing and optimising the cycle. WHR ORC cycles usually opt for flammable working fluids, as the resulting plant performances are higher with lower resource temperatures. However, this choice impacts on the safety of the plant operation.

Thanks to the ROT configuration, unique in the ORC marketplace, Exergy could design an innovative cycle using R1233ZDE, a non-flammable refrigerant, as working fluid for the ORC. Due to its exclusive radial configuration, different from the axial turbine normally employed in ORC cycles, the ROT is able to convert the energy contained in the organic fluid into mechanical power with higher efficiency (up to 30 per cent).

Among other advantages provided by

the ROT are the optimal match with the heat release curve, and better operation at partial loads.

For the Pederobba cement plant, with the use of the patented ROT technology and the tailored cycle design, Exergy has obtained 20 per cent higher efficiency than any other existing ORC WHR unit for cement plants using non-flammable working fluids.

The 3.5MWe of electrical energy produced by the WHR ORC unit will feed approximately 30 per cent of the cement plant's energy demand. Furthermore, the plant will save approximately 5400toe per year, thanks to a decrease in the use of fossil fuel-generated electricity, and about 17,000t of CO₂ per year by exploiting the exhaust gases coming from the clinker cooler.

Exergy will deliver the completely-functioning plant in the second half of 2019.

Benefits of the ORC option

Thanks to the compact and modular design of ORC technology, the flexibility to be located away from the heat source if required, the better efficiency for lower temperatures (from 90 °C up to 350 °C) and the automated operation, ORC WHR plants are now a proven technology for cement plants.

Exergy has boosted ORC WHR technology to a higher level with the use of ROT technology, offering higher efficiency of the cycle and safer operation of the plant with the use of non-flammable working fluids, without any compromise on efficiency and increasing overall plant profitability. ■