Marseille uses the potential of the Mediterranean for heating and cooling buildings

By **Bryan Orchard**

Developing new sustainable, ecologically acceptable technologies for heating and cooling domestic and commercial premises have been challenging the resources of many energy companies around the world. Harnessing the potential of the sun, sea tides and currents, the wind and heat trapped deep beneath the earth's surface have all proved to be successful technologies to varying degrees. To these can be added the thermal energy of the sea.

The sea provides enormous potential as an energy source for the world's population that lives within 100km of the coastline. This has not gone unnoticed by ENGIE Group, which has developed energy from tides and currents around the world. Now, it has turned its attention to the calorific energy of the Mediterranean Sea by turning it into space heating and cooling with the construction of a generation plant in Marseille Harbour. Called the Thassalia Marine geothermal project, the €35 million plant is a first of its type in Europe and will eventually provide a sustainable energy source for 500,000m² of buildings in the new Eco-Cité Euroméditerranée, currently the largest urban renewal operation in Southern Europe.

Eco-Cité Euroméditerranée occupies 480 hectares in the heart of the Marseille — between the commercial port, the Old Port, and the TGV station — and offers housing, shops, hotels, restaurants, commercial premises, public services and cultural facilities. The development of the Thassalia plant is central to the Eco-Cité Euroméditerranée with it being given HQE (High Quality Environment). As a referral project for renewable energy due to the recovery of about 70 per cent of the marine thermics/frigories, Thassalia has an extremely high energy efficiency coefficient as compared to an equivalent infrastructure equipped with stand-alone heating air conditioning units. The result is a 70 per cent reduction in greenhouse gas emissions for the eco-city, plus a 40 per cent reduction in electricity consumption and 65 per cent reduction in water consumption.

The Thassalia Plant

The development of the Thassalia plant by the Engie Group commenced in 2010 and brought together the expertise of its subsidiaries ENGIE Coffley and Climespace. In fact, working with ENGIE Group right from the very start was KSB France, which supplied pumps, valves and the engineering resources of its services agency based in Aix-en-Provence. Operationally launched in 2014, the plant was inaugurated on 17 October 2016.

The basic premise of the project concerns the creation of a hot and cold water network throughout the Euroméditerranée perimeter. It is innovative in several ways. Firstly, Thassalia is a thermo-refrigeration plant that delivers heating and cooling, where most often the networks in France are separated. Secondly, energy is drawn from seawater, and lastly, it is the first European project to circulate heating and cooling throughout the whole of an eco-city of this magnitude.

Fig. 1 Courtesy of ENGIE Group
Seawater circuit

Priority pump	: KSB Mega CPK 250-400 Noridur® anti-corrosion steel
Fluid	: sea water
Nominal flow	: 720 m^3 / h
Nominal HMT	: 48 mCE
Suction pressure	: 3 bar
Rotation speed	: 1500 rpm
Yield	: 80%
Power	: 160 kW

How it works

Central to the whole operation of the plant and distribution network are pumps, which is where the know-how and products of KSB are essential. The thermal plant is supplied with seawater pumped from a depth of 7m by six corrosion-resistant Norstur® KSB CPKN pumps, each equipped with a 160kW variable speed motor, for a total flow of 1000 lt/s. The problem of corrosion by warm seawater is peculiar to this project, with the pumped water reaching up to 25 °C in summer and its permitted discharge temperature being 30°C. The parts of the pump in contact with the fluid have therefore, been made of special Noridur® duplex steel (KSB design, Uranus equivalent B6). Noridur® is used for highly corrosive and slightly loaded products, such as warm seawater but also for concentrated acids and flue gases in desulfurisation processes.

For the same reasons, the discs of AMRI Isoria butterfly valves, which perform the isolation or regulation functions of seawater intake are protected with a Halar corrosion coating. These valves - from DN50 to 700 - provide both manual and pneumatic actuator operation. The sea water, which ranges in temperature from about 14°C in winter to 22°C in summer, supplies heat exchangers connected to thermo-refrigeration pumps (TFP), bringing calories to heat when the water is cold and frigories to refresh when it is hot. The TFPs and refrigeration units can then produce heat or cold as required. It should be noted that supplementary gas boilers complete the installation in order to guarantee continuity of service in all circumstances.

The energy is then transported to the Euroméditerranée buildings for heating or air-conditioning via a hot water network (60°C) and a chilled water network (5°C). The length of the 3km network demanded powerful pumping solutions with strong HMT on both hot and chilled circuits.

These two circuits are each equipped with four KSB Mega-CPK pumps (eight in total) each displaying a nominal HMT of 110 mCE or 120 mCE depending on the motors and power ratings ranging from 160 kW to 355 kW. This "secondary network" requirement was a determining factor in the choice of pumping solutions. Indeed, the requirements of the specifications were very high not only in terms of height, but also in efficiency and speed. Thus, the Mega CPK retained yields up to 84 per cent at speeds of 1500 rpm and 1750 rpm.

An alternative to this arrangement would have been to consider a "lighter" solution in terms of pump sizes, making them easier to install and less expensive. However, in this case, there was no pump sufficiently powerful enough to provide the required HMT alone, hence, it would have been necessary to resort to pumps in series. Such a mode of operation would have been riskier in terms of reliability for the operator.

And so, this option was finally discarded.

In addition to these pumping duties, the auxiliary circuits are equipped with Etanorm pumps operating at 650 m^3/h for 30 mCE and with a power of 75kW, and Etaline pumps for the heat exchangers and recycling duties. Furthermore, 150 AMRI Boax B valves, with manual or pneumatic control ranging from DN100 to DN600 were also installed.

What are the benefits?

Significant “collateral” benefits must also be credited to marine thermal energy. On the environmental front, the centralised production of cold favours a reduction of the heat island effect in the city, a factor that would have created a multiplication of individual units. Moreover, in a refrigeration network, the roof terrace surfaces are cleared due to the removal of cooling towers on the top of the buildings. Their removal also limits noise pollution and drastically reduces the risk of bacterial contamination, with legionella being an example.

On the financial level, the price of the energy produced is about 10 per cent lower for centralised cold production as compared to a solution using individual units. In addition, centralisation is less sensitive to increases (if any) in electricity and gas tariffs.

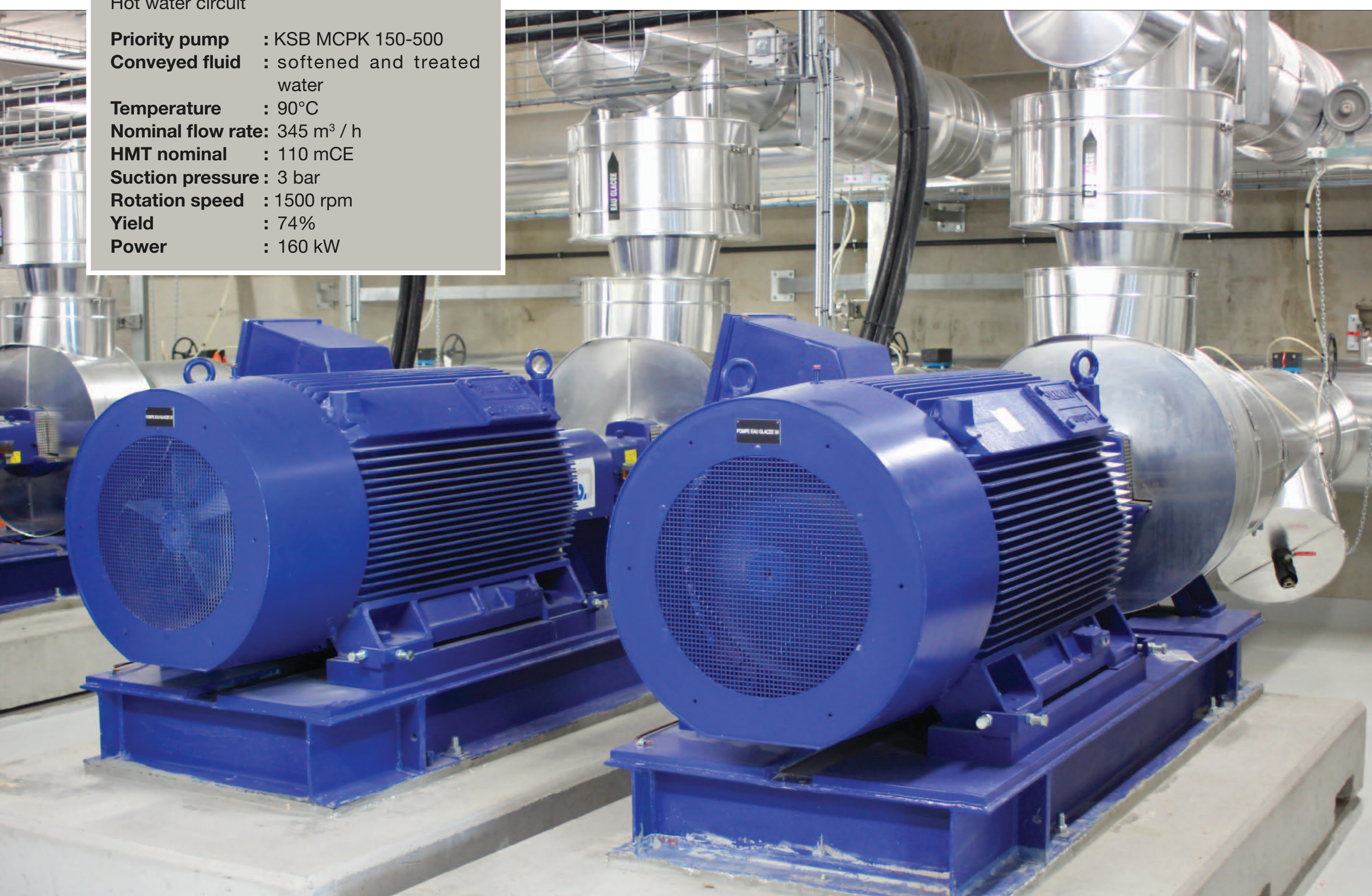
Pumping energy efficiency

Pumps are components of systems that consume large quantities of electricity and therefore, have great savings potential. To illustrate the high stakes: The annual consumption of industrial pumps in the EU is 300-TeraWatt hours (= 300,000 GigaWatt hours). By way of comparison, France’s total electricity consumption in 2015 was “only” 461-TeraWatt hours. It is, therefore, understandable that the EU has set ambitious targets for our products through the Energy-related Products (ERP) Directive.

KSB’s response, which can go far beyond these objectives, is called Fluid Future. This “global” device functions on many levels. With regard to the drive, the motor of the pumping unit can save about 10p per cent. By working on optimising the hydraulic efficiency of the pumps, savings can reach 20 per cent. By analysing and

Hot water circuit

Priority pump	: KSB MCPK 150-500
Conveyed fluid	: softened and treated water
Temperature	: 90°C
Nominal flow rate:	345 m^3 / h
HMT nominal	: 110 mCE
Suction pressure	: 3 bar
Rotation speed	: 1500 rpm
Yield	: 74%
Power	: 160 kW



optimising the entire circuit, the potential can rise up to 6 0per cent!

The search for the energy saving in a fluid transport circuit concerns both new and existing installations. For the latter, the results can be spectacular. Indeed, not only are the technical solutions in place subject to improvement, but it is also not unusual for the needs of the installation to have evolved over time (new process, modification of the network, etc.).

The Fluid Future device consists of four phases:

1. Analysis of the hydraulic system in place and determination of the load profile.
2. Selection of the adapted solution (hydraulic, drive, automation) resulting from the collected data.
3. Control of the installation and/or commissioning by "KSB Service" specialists.
4. Equipping the installation with technologies that will contribute to the energy efficiency of the installation. Examples would be the SuPremE® reluctance motor (IE5), PumpDrive 2 speed controller, and PumpMeter intelligent pressure sensor.

Summary

The current and future residents and workers of Euroméditerranée Éco-cité will reap the benefits of a heating and air-conditioning network that is energy efficient and environmentally friendly created by a thermal plant with an installed power of 19 megawatts hot and 19 megawatts cold capability.

For KSB France, the problems which they had to overcome involved providing pumps and valves that would have to resist higher than normal levels of corrosion. In addition, other key factors that had to be addressed, included providing pumps with high yields for limiting power consumption, contributing to the award of the HQE label, and minimising the acoustic power of pumps to avoid "neighborhood" noise nuisance. And finally, KSB will provide a rapid response for maintenance and repair throughout the life of the plant. **WWA**

All images are courtesy of ENGIE Group.

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Ice Circuit Courtesy of ENGIE Group

Priority pump	: KSB Mega CPK 200-500
Conveyed fluid	: softened and treated water
Temperature	: 9°c
Nominal flow	: 760 m^3 / h
HMT nominal	: 120 mCE
Suction pressure	: 3 bar
Rotation speed	: 1750 rpm
Yield	: 84%
Power	: 355 kW