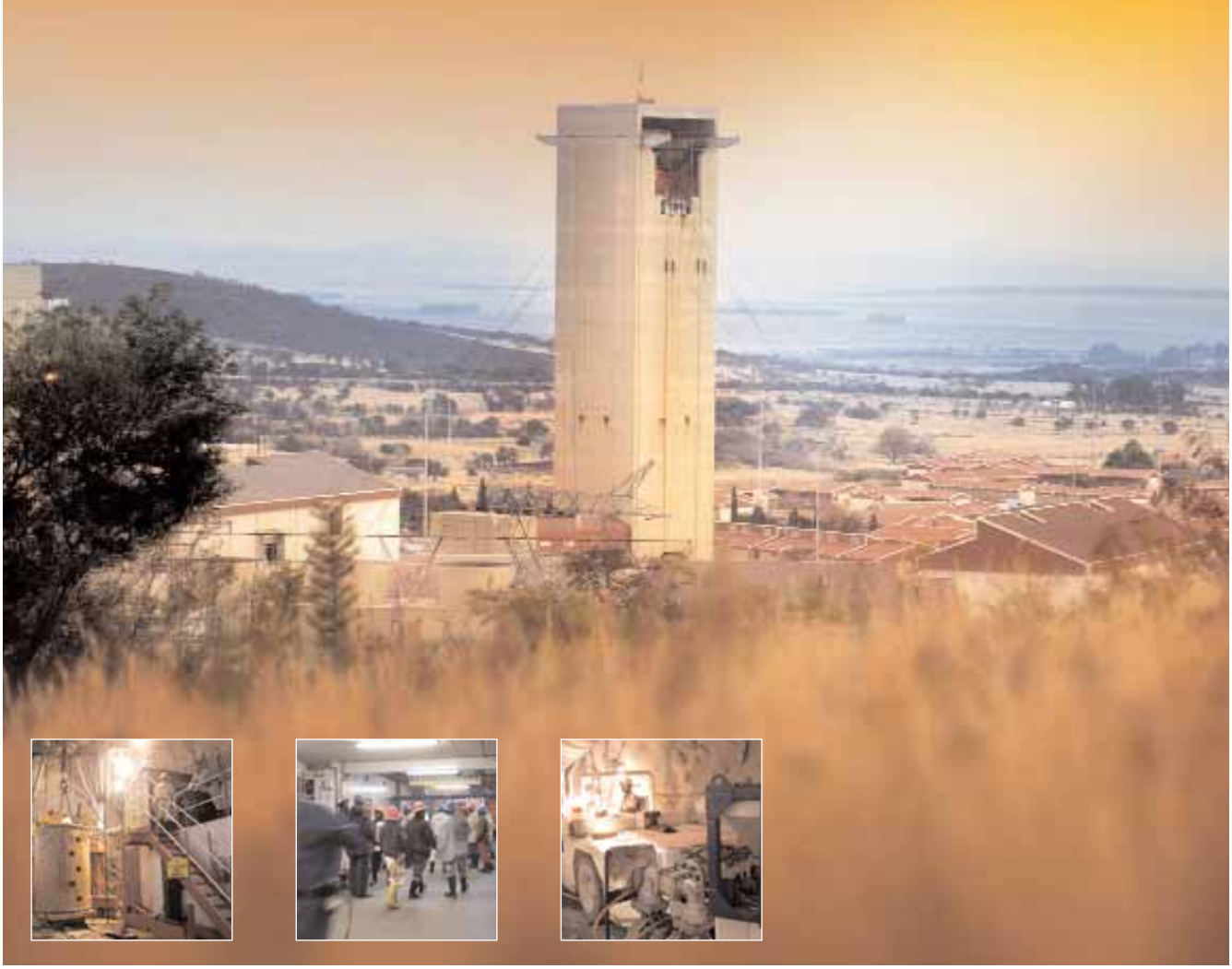

Energy recovery at Mponeng using ice

AngloGold Ashanti has installed a new cooling system at Mponeng mine in pursuit of improved energy efficiency. Mponeng is one of South Africa's deepest mines, with virgin rock temperatures reaching up to 54.5°C at 3.5km below surface. Cooling systems are essential in keeping temperatures in underground working areas below the threshold of 27.5°C wet bulb which is considered safe for employees to operate in. (*See case study in Report to Society 2004.*)

Most mines use water as their primary cooling medium. The water is cooled in a refrigeration plant (situated either on surface or underground) and is distributed to various locations in the mine. One of the disadvantages of this configuration is that the plant is generally situated at a distance from the rock face and the water heats up as soon as it leaves the chillers, thereby adding to the energy and cost requirements.

With calls for improved energy efficiencies, Mponeng looked at alternatives to its traditional cooling system, comprising a large refrigeration system with dams, cooling towers and five 11MW conventional refrigeration plants which cool service water from 10°C to 3°C for circulation inside the mine.

The mine also installed three underground generator/turbines as part of its underground cooling system to make use of the gravitational energy released by the water falling to the bottom of the mine. This energy drives two 1.8MW generators and a single 2.8MW generator 24 hours a day, seven days a week, which equates to a total of 32GWh of electricity being generated per month which equates to save 2.3% of Mponeng's total consumption.

With the Montreal Protocol (see box below) aimed at phasing out ozone-depleting substances (e.g CFC-based refrigerants). Investigations were carried out some years ago into alternative refrigeration systems to increase cooling efficiency and to reduce costs. In partnership with Israeli Desalination Engineering (IDE), which developed vacuum ice technology, AngloGold Ashanti researched the viability of cooling the mine with ice. In 1992, the mine commissioned its first 1,520 kWh pilot vacuum ice plant and today has a 76MW-installed refrigeration capacity, circulating 49 Ml of chilled water through its water-cooling system. Six IDE-built 3MWR vacuum ice plants produce 4,200t of slurry ice daily.

Pre-cooled feed water is subjected to a vacuum to produce ice – which is formed by lowering the freezing point of water in a saline solution. Together with the service water, the ice is used to help keep the underground wet bulb temperature below 27.5ºC. The application of vacuum ice technology has had the effect of reducing operating costs significantly.

Another advantage is that the same cooling result is achieved with a fivefold reduction in the water required, which also contributes to energy savings. By sending ice underground and making use of its latent heat capacity in melting, there are significant operational cost benefits, especially at depths below 3,000m (latent heat capacity is the measure of the intrinsic heat energy required to increase the temperature of a substance).

Mponeng's ice is stored in ice-dams at different levels of the mine, readily available to cool the water closer to site instead of first pumping it to surface. Although ice plants are slightly more expensive than conventional refrigeration plants, the initial capital expenditure is offset by lower pumping requirements associated with the reduced volumes for the same refrigeration capacity.

Ice technology is being used extensively at Mponeng mine, which has embarked on a new ice thermal storage system to produce and store enough ice to reduce the load on the refrigeration machines during peak electricity times. This project is run as part of a demand side

The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987 and has been updated many times since then, mostly recently in September 2007, when an accelerated phasing out programme for HCFCs was agreed.

Energy recovery at Mponeng continued

management (DSM) initiative (*see case study: National Energy Efficiency Accord at www.aga-reports/07/NEF-sa.htm*) with the assistance of energy services company. The mine has built a new 45Ml ice storage dam and has installed a number of ice coil banks inside the dam, which will soon be operational.

To produce ice, a subzero (normally about -3ºC) water/brine mixture is circulated through a refrigeration plant and ice coil banks during off-peak times. During peak times, the ice is melted again by pushing water over the ice banks, thereby providing a ready supply of cooled water for mine circulation. The system can be 'recharged' during cheaper electricity tariff periods to reduce the load on the other refrigeration plants during periods of high demand. This system will see the mine reduce its energy demand by as much as 10MW of electricity during peak times and bring about expected annual electricity savings of approximately R2 million, some 2% of Mponeng's total annual cor of consumption.

The newly installed ice-thermal storage facility is an important part of the mine's broader energy management strategy, which aims to reduce costs and improve energy efficiencies.