Inner city energy centre for Absa's

The recently occupied Absa Towers West building in Troye Street Johannesburg is the latest addition to the Absa Campus, which now comprises nine buildings spread across Commissioner and Anderson and Von Wielligh and Mooi Streets in central Johannesburg. Absa Towers West is not only built to be one of the most eco-friendly and energy-efficient buildings in South Africa, but as a result of the power uncertainty created in 2007, the entire campus is also self-sufficient. An energy centre capable of generating the maximum demand for the entire campus – 11,2 MW from gas powered engines and 6,0 MW of emergency backup from diesel units – has been installed in the car park of the new building. *Peter Middleton* takes a tour of the facility.

Absa Towers West is a sparkling new building just east of central Johannesburg, in an area that was only a few years ago being cited as evidence of the 'death of Johannesburg'. The city is clearly experiencing 'rejuvenating times' but it remains a surprising location for a first-of-a-kind South African commercial cogeneration project. "Our philosophy as a bank is not only to be saying the right things, but to be doing them. In the energy context, we strive to be an advocate for clean, green, reliable and economical energy solutions," says Hope Mashele, Absa's manager for engineering and energy.

The Absa energy centre development team: Coert Scholtz, Diesel Electric Services; Leon Jansen van Vuuren, GE's head of sales for Jenbacher gas engines; Robert Ladbury, manager for critical engineering, Absa; Ken Gafner, Single Destination Engineering; and Hope Mashele, Absa engineering and energy manager.

One of the four J 620s from GE installed at the Absa energy centre in Johannesburg. These 20 cylinder reciprocating gas engines have a peak generation capacity of 2,8 MW each and emit 40% less greenhouse gases than coal-based generation, making them one of the cleanest combustion based technologies available.

Being linked to Barclays Bank has led Absa to voluntarily align itself with its global parent's emission reduction commitments. "But South Africa also has very good potential for energy efficiency improvements," Mashele adds. So, along with the new energy-efficient building, Absa has included an energy centre as an integral part of the development and installed all of the reticulation required to share the energy generated across the whole of Absa's Johannesburg campus.

The motives? "The initial thinking was driven by the power outages and load shedding schedules of 2007 and 2008. But we could have gone in several different directions. Renewable solutions are always considered, but gas emerged as the most resilient and popular option," he continues. "With emissions reductions on offer of at least 40% compared to diesel or coal, it was an obvious choice for power generation that was compatible with our green commitments." Also driving Absa's choices is the support of technology initiatives by local service providers and to create momentum towards energy efficiency and emissions reductions. "It is with this in mind that we chose GE Jenbacher gas engine business, through GE South Africa, for the gas engines and Diesel Electric Services, a truly South African company, for the installation and long term maintenance service contract," Mashele informs *MechTech*.

Robert Ladbury, the manager for critical engineering at Absa gives a summary of the facility's key features and use: "The Energy Centre is based in Absa Towers West, but we have installed reticulation to connect it across all nine buildings in the Johannesburg city campus," he says. "During normal operation, the key idea is to take our maximum demand from City Power down." So during the day and throughout the peak demand period, Absa generates its own power at the energy centre, synchronises this power to a fixed power draw from the grid, and then supplies the total campus demand. "The total peak load of the campus is around 12,0 MW during the day, so we are drawing a fixed 7,5 MW from City Power and, between 6:00 am and 10:00 pm, we operate engines running on Egoli gas to generate the balance," he explains.

Johannesburg campus

The new Absa Towers West building, one of the most energy-efficient buildings in South Africa. The use of natural light is maximised and supplemented by an automatic system that measures the lux levels and maintains comfortable working light.

Plate heat exchangers make use of rejected heat from the engines' cooling systems for low temperature domestic hot water. GE Jenbacher gas engine business believes that a 'trigeneration' approach can result in net efficiencies of above 80%.

The core of the energy centre's generation capacity comes from four of GE Jenbacher J 620 gas engines, each capable of producing a peak output of 3,0 MW, but optimised into the Absa energy centre to peak at 2,8 MW. "We manufacture gas engines in the power range from 200 kW to 4,4 MW per unit," says Leon Jansen van Vuuren, GE's head for sales for Jenbacher gas engines in Africa, the Middle East and South Asia. "Our engines can run on natural gas, landfill gas, biogas, coal mine methane, coalbed methane, steel gas from the smelter industry and a variety of other speciality gases. We are very proud of the Absa project, which is the first project of its kind in the financial sector," adds Jansen van Vuuren. "Absa is the kind of local company that fits well with our philosophy: to manage energy use as cleanly, efficiently and reliably as possible and this project is particularly notable for demonstrating the emissions savings that are possible by switching to gas."

Summarising the gains already achieved by the energy centre, Ken Gafner of Single Destination Engineering (SDE) and the design engineer for the centre, points out that before the energy centre was installed, Absa was using 81-million kWh of electricity per year, all drawn from the utility. "As we stand at the moment in phase one of the project, we are drawing 54-million kWh and generating 26-million on our own. This reduces emissions from 97 000 t to 78 000 t per year, the equivalent of planting 1 900 Ha of forest," he says.

But this is not where the project stops: "In the future, by using the waste energy from the engines of this plant more effectively, we will be able to drop the power required from the utility down to 28-million kWh, a massive reduction. And even though we will be generating the same amount of power from our engines, the total emissions will drop to 66 000 t, ie, the total emissions of the Absa Campus will be reduced by 1/3 because of our energy centre," he points out.

Absa Towers West is the green building pioneer on the campus with several energy-efficient features incorporated into its design. The use of natural light is maximised and supplemented by an automatic system that measures the lux levels and controls total lighting to the levels required. Sensors are also used to automatically switch off electrical lighting 15 minutes after everyone has left an office. "But the air conditioning and heating is our biggest consumer. So at night, we flush out the whole building with natural cold air. Cool air is drawn in from the bottom of the building and used to push all of the hot air out at the top. This significantly reduces the amount of mechanical power we need to use to keep the building cool during the day," Mashele explains.

As with any engine, there are substantial amounts of waste heat available from both the cooling systems of the engines and the higher temperature exhaust gases. "This heat is available for use for campus heating or for cooling via absorption chillers," Gafner explains. At present, most of the campus buildings predate the energy centre and weren't designed to use low temperature hot water (LTHW) – "but Absa Towers West, was. We are using approximately1-1,5 MW of LTHW during summer and winter for Towers West alone. It is used for heating coils in the air handling units and for domestic hot water for the showers, etc – and this is a direct saving that comes straight off the electrical load of the building."

But substantial amounts more waste heat is accessible. "So, as more buildings are upgraded, we expect to see increasing amounts of LTHW being used, which will again reduce electrical demand." In addition, the centre is also designed to recover the higher temperature exhaust waste heat, which is much better suited to absorption chillers. Chilled water can then be pumped to any of the campus buildings to reduce air conditioning demand from traditional compression/expansion cycle chillers.

After a walk around a JHB city block, we are ushered into the energy centre and shown four of GE's Jenbacher

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J 620s. Two are operating and two are idle. In the control room, Gafner shows us the load status of the campus: the total shows 11,6 MW; a flat blue line sitting at 7,5 MW is the draw from City Power; and a less flat red line at just over 4,0 MW is being generated from the two working gas-engine generator sets. "With four engines installed, we have the capacity to generate almost all of the peak demand, but currently, we are operating an economically optimum combination, ie, two of the gas engines at 75% of full-load. For the future though, four additional bays are provided for future engines and absorption chillers."

In event of a major power failure from the utility, diesel generators, at the energy centre and those previously installed in the campus' other buildings, will automatically start. "But in the background, the diesels here are also being used to start up the gas engines ready to support the full campus load." After 15 minutes or so, once the gas engines are up to speed, then the energy centre supplies all the power via the campus reticulation system. Local campus diesel generators see that power has been restored, and while not knowing whether the utility or the energy centre is supplying, they shut off. Then, when utility power is restored to the building, the gas engines will automatically and seamlessly synchronise and generation from the gas engines is reduced and/or shut down until the load requirements are optimally met.

"Looking at the whole picture, we may also be able to supply external companies with energy in the Johannesburg region," adds Mashele. "We are legally prevented from doing so at the moment, but we are in consultation with the City and it might make sense in future."

Jansen van Vuuren tells us how the J 620s work: "This is a 20 cylinder reciprocating engine with a volume of 6 000 cc per cylinder. Natural gas comes in from the off-take and through pressure-control valves, it is mixed with air and compressed via turbochargers, forced into an intake manifold, then into the cylinders when the valves open, and ignited by sparkplugs.

"Radiators on the roof are used to cool the oil and water circuits and slightly overpressure ventilation is provided on the air intake side. In the event of any gas leak, the engines stop and the fan accelerates to disperse the gas safely and quickly. There is never a risk of a gas explosion with these units," he assures us.

Through a process called Lean-Ox®, the air/gas mix can be continuously optimised to give lowest emissions on the one hand or highest power on the other. The power output is also continuously variable, but the machines are designed to run continuously.

Incoming gas is at very low pressure, which makes it an extremely safe transporting mechanism. The main gas valve is held open against a spring and will shut-off automatically as soon as any sensor detects a leak.

Gafner points out the heat recovery systems: Heat exchangers are designed into the exhaust ducting of each engine for future use with absorption chillers, and plate heat exchangers are already being used to heat LTHW for Absa Towers West. "Any heat that we don't use is rejected via cooling towers on the roof," he says.

"The design philosophy is to use as much of the thermal waste energy as possible," adds Mashele. According to a GE Jenbacher gas engine business report, this 'trigeneration' approach – the use of gas engines to generate power, heating and cooling – can result in net efficiencies of above 80%. And the entire infrastructure is in place to take full advantage: around 100 sleeves of between 300 and 700 mm in diameter are installed for the distribution of power, LTHW and chilled water. "Over 4,5 km of 11 KV cables link the buildings and hot and cold water piping is in place to enable Absa to make increasing use of the thermal energy as each building gets refurbished. This will give us a massive reduction on the demand side," adds Gafner.

We are then taken to the gas off-take area. Incoming gas is at very low pressure, which makes it an extremely safe transporting mechanism. "We don't hold reserves, either. We use a continuous piped supply from Egoli Gas." For safety, the main gas valve is held open against a spring and will shut automatically as soon as any sensor detects a leak.

"This is a substantial gas supply, 240 000 MJ/year. We have been running since May last year and used just on 5-million cubic metres of gas, and each cubic metre is the approximate equivalent of one litre of diesel," Gafner informs us. "We have generated 20-million kWh in 10 000 h of operation. So far we have used nearly 80% of our gas allocation for the first year, so the plant is doing exactly what it was designed to do," he points out.

The costs? "Our direct running costs, including the maintenance contract with Diesel Electric Services, are currently sitting at R1,00 per kWh," responds Gafner. This compares very favourably to City Power's winter peak tariff, which is already at between R1,30-R1,40 per kWh. And the comparison between gas and diesel costs? "Diesel generation costs in the order of R2,40 per kWh, just because of the fuel price difference between diesel and natural gas." And when the waste heat savings are fully realised, then the economics will make even more sense.

"This is a very nice project on a commercially sensible scale," says Mashele. "It is not a pilot plant either, it's a real inner-city power generation facility. But we don't want to ring fence any one reason for building it. We are not simply motivated by costs.

The combined equation is what makes business sense, the holistic approach. It's about being efficient, cost effective, community aware and environmentally sensitive all at the same time," he concludes. "And if at some point we are able to export energy to the grid, we already have capacity and the potential to expand." ❑