Electricity smart HVAC systems:

Reducing energy costs in the hospitality sector

Brochure

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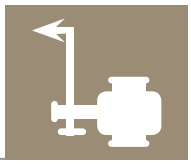

There is an increased awareness amongst hotel operators of the importance of minimising the negative environmental and social impact of their operations. They have also seen that improving the energy efficiency of their properties can quickly deliver lower operating costs and that wastage of resources can be reduced without compromising the customer experience.

The major hotel chains have developed their own branded sustainability programmes, which they use to drive change within their organisations and to engage their guests. Hotels are also using independent environmental certification programmes like EarthCheck to validate their carbon claims and guide their sustainability initiatives.

Social media apps and websites like TripAdvisor help travelers check the environmental performance of the hotels and resorts they are considering.

Guests expect today's establishments to follow the very latest trends in technology to provide them with a more interactive, customised experience during their stay. Internationally, technology developments include:

- Guests doing remote check-ins via their smart phones to give them instant access to their rooms.
- Guests playing their own content from media players on the televisions in their hotel rooms.
- Smart apps giving clients a 'concierge service' in their pockets.

Technology extends to sustainable practices in hotels as well, such as smart thermostats that can determine when to automatically cut back on heating and cooling if a room is unoccupied.

The rising costs of electricity make sustainability and energy efficiency the new buzzwords in hotel development. Developers may have to accept marginally increased capital expenditure costs to implement sustainable designs and technology. They will, however, share in the long-term savings on operating costs.

Moreover, increasingly tight construction programmes have made modular design an important consideration. This trend offers a number of benefits, including cost savings due to several components of the construction being created off-site. While the 'common areas' of the hotel are often built on-site, modular design means that many smaller sections can be created elsewhere and installed relatively quickly.

Hospitality sector: an overview

South Africa attracts a mix of business and holiday travelers and offers a wide range of hotel classes and accommodation.

Although growth in South Africa's economy has weakened, growth in international travel and rising room rates have bolstered the market. Total room revenue in South Africa rose by 14.0% in 2013 and hotel-room revenue increased by 14.6%.[1]

Outlook: room revenue in South Africa (R million).[2]

	2014	2015	2016	2017	2018
Overall	19 430	21 629	23 935	26 321	28 736
% change		11.3	10.7	10.0	9.2
Hotels only	14 144	15 620	17 250	19 039	20 873
% change		10.4	10.4	10.4	9.6

- It is expected that South Africa's hospitality sector will expand at a 10.7% compound annual rate overall (and by 11.2% compounded annually for hotels). Growth in room rates will be the principal driver in South Africa, aided by the positive impact of the depreciating Rand on the number of foreign visitors and by growth in real terms following a period of low rate increases.[1]

1. PriceWaterhouseCoopers. www.pwc.co.za/hospitality-and-leisure
2. PricewaterhouseCoopers LLP, Wilkofsky Gruen Associates

Energy use in hotels

The hotel industry constitutes one of the most energy- and resource-intensive branches of the tourism industry. Substantial quantities of energy are consumed in providing comfort and services to guests, many of whom are accustomed to, and willing to pay for, exclusive amenities, treatment and entertainment. The energy efficiency of the many different end-uses in hotels is frequently low and the resulting environmental impact is, therefore, typically greater than those of other types of buildings of similar size.

Energy use varies substantially between different types of hotels and is affected by:

- Hotel size;
- Class and category;
- Number of rooms;
- Customer profile;
- Location (urban / rural / remote);
- Climate of the area; and
- Types of guest services, amenities and activities provided.

A hotel can be seen as an architectural combination of three distinct zones, all serving distinctly different purposes:

- Guest room area (bedrooms, bathrooms with baths, showers and toilets) – individual spaces, often with extensive glazing, asynchronous utilisation and varying energy loads.
- Public area (reception area, lobby, bars, restaurants (indoor and outdoor), meeting rooms, swimming pools and gardens) – spaces with a high rate of heat exchange with the outdoor environment and high internal loads (occupants, appliances, equipment and lighting).
- Service area (kitchens, laundry rooms, store rooms, machine rooms, staff facilities, offices and other technical sections) – energy-intensive areas typically requiring advanced heating, ventilation and air conditioning.

HVAC systems account for a major portion - frequently up to 50% - of energy consumption in a hotel.

Heating, ventilation and air conditioning physically affect guests' wellbeing, so it is important to choose a system that both reduces energy consumption and improves comfort.

1. PriceWaterhouseCoopers. www.pwc.co.za/hospitality-and-leisure
2. PricewaterhouseCoopers LLP, Wilkofsky Gruen Associates

Tips to reduce HVAC costs

Keep the following in mind:

- Switch off systems in all unoccupied spaces.
- Chillers -
  - Replace old chillers with a water-cooled turbo compressor fitted with a Variable Speed Drive (VSD) - this can improve energy efficiency by up to 400%.
  - Use a smaller capacity chiller for low load conditions and a larger chiller for high load conditions.
  - Operating a chiller at part-load conditions reduces the efficiency of a conventional fixed speed chiller.
  - If the expansion valve is electro–mechanical, replace it with a modern electronic valve - this can improve efficiency by around 15%.
  - Use a chiller with a remote set point-control facility.
  - Increase the cooling tower capacity – this can increase chiller efficiency.
  - Use a common cooling tower for all chillers with a common header and discharge.
  - Use VSDs for the following areas:
    - Secondary chilled water pump.
    - Primary chilled water pump.
    - Condenser water pump.
    - Cooling tower fans – VSDs on fans also improve the energy efficiency of the chiller compressor.
  - Tune the control system to avoid simultaneous heating and cooling.
  - Insulate ducts and chilled water pipes to prevent heat gain.
- Infiltration of air -
  - Reduce the infiltration of ambient air into air-conditioned spaces as a means of lowering the air conditioning load - the guest entrance door in the foyer of a hotel is an area where automatic double doors or revolving doors can be considered.
- Economiser (Logic HVAC Controller) -
  - Install an economiser – it improves the energy efficiency of HVAC systems and is especially viable when implemented during the installation of a system for functioning in very hot or cold conditions.

Using a collection of dampers, sensors, actuators and logic devices, an economiser decides how much outside air can be brought into a building, allowing the load on the cooling system to be reduced.

- Dampers regulate the amount of air introduced, recirculated or exhausted from the building.
- Outdoor temperature sensors and logic controllers determine whether conditions are right for the economiser to govern the operation of the outside air damper.
- Actuators open or close the dampers based on signals from the logic controllers.
- When the logic controller decides the outside air temperature is low enough to take some or all of the cooling load, the outside air damper opens and the air conditioning compressors are turned off.
- For the process to run effectively, an exhaust fan always runs when the economiser operates to ensure the same amount of air will be exhausted from the building as is taken in.
- When the outdoor air temperature rises too high to provide useful cooling, the outside air damper moves to a minimum position, maintaining minimum ventilation. The compressors then take over the cooling process.

Economisers require regular maintenance and testing to ensure optimal performance.

Energy costs in hotels typically amount to a small percentage of overall operating costs, but represent a substantial proportion of controllable costs – often second only to labour costs.

More on VSDs

A VSD, also known as a Variable Frequency Drive (VFD), is a device that can adjust the frequency to regulate and adapt motor speed to match the actual demand required by HVAC systems, resulting in a reduction of energy consumption.

VSDs offer a high degree of motor control, accurately varying motor speed according to demand while adjusting torque accordingly – all within the specifications of a particular manufacturer.

A basic VSD can be used for simple applications - such as controlling a pump or a fan - where variable loads are required. It can also be interfaced with a transducer (such as a pressure or flow rate sensor) and programmed to maintain a particular setting.

More advanced VSDs can be interfaced with a computing system to provide real-time operating data on the status and performance of a motor.

Slowing down a pump from 100 to 80% can reduce motor energy use by up to 50%.

How does a VSD work?

All VSDs work on the same principle: they convert incoming electricity, which is at a fixed frequency and voltage, into variable frequency and voltage.

When a VSD starts a motor, it initially applies low frequency and voltage, typically 2Hz or less, which avoids the high starting current that occurs when a motor is started using a direct-on-line or star-delta starter method. The applied frequency and voltage are increased at a controlled rate to increase the speed of the motor (load) without excessive current being drawn.

Drives adjust the speed of electric motors to match the actual demand of the application, thereby reducing motor energy consumption typically by 20 to 50%.

How VSDs save

VSDs save energy because they prevent motors from using more electricity than required - many motors are oversized to cope with a maximum demand that rarely or never occurs.

When other control methods are used, such as valves, motors run at full speed and the flow of the output is mechanically restricted. This is wasteful, because the motor keeps running at its nominal speed regardless of demand. A pump, for instance, delivers maximum output and the excess is reduced at the valve where the surplus energy is wasted through friction.

A pump or fan running at half speed consumes only one eighth of the power compared to one running at full speed, which means a small increase in speed requires a lot more power.

VSDs deliver accurate control and less mechanical wear, reducing maintenance and extending the life expectancy of systems.

The advantages of VSDs go beyond improved energy efficiency - they:

- Enable precise control over applications and help to control pressure, flow and temperature;
- Allow for soft starting, which can reduce stress on motors and bearings and, therefore, extend equipment life;
- Enable more frequent starting and help to reduce motor overheating;
- Allow for dynamic braking to decelerate loads in a quick and controlled manner;
- Help to improve the power factor;
- Allow for the rapid adjustment of speed, torque and power to provide better control in high speed applications;
- Deliver meaningful intelligence on the status and performance of motors when interfaced with computers or wider process control systems;
- Avoid penalties for exceeding the supplied kVA; and
- Can run more than one motor at a time if the load on the motors is equal – in fact, up to six fans with the same load can be controlled by one VSD.

When linked by remote control, VSDs can be used to switch off motors or lower the speed of fan or pump motors, to decrease the air or water flow rate during Eskom's peak hours of demand for electricity.

Some VSDs can regenerate power - there are options where the rectifier stage is similar to the inverter stage, making it possible to return energy recovered during the electrical braking of the load to the electricity supply.

- A smart VSD with a built-in Programmable Logic Controller (PLC) can do sequence starting and sequence stopping and, therefore, replace a number of devices.

When a motor is started at full voltage without the use of a VSD, it could draw up to 400% of its rated current, whilst producing only 50% of its rated torque.

Putting VSDs to work

- Before installing a VSD, make sure your HVAC system is efficient and correctly sized for its application; only opt for a VSD if it is the correct electro-technical solution for your hotel.
- VSDs must be correctly installed to operate optimally and achieve the intended energy savings – always select an expert installer who can back up his/her product and who understands the operating profile of your HVAC system.
- Once installed, VSDs must be correctly programmed to deliver the intended energy savings - setting incorrect parameters will result in poor control and energy wastage.
- Like all electrical equipment, VSDs are susceptible to damage from humidity and inadequate cooling and need to operate within specified temperature and humidity parameters.
- Ventilation and/or air gaps must be provided (according to manufacturers' specifications) to prevent overheating; VSDs should be located near the motor in suitably ventilated enclosures or remotely in a suitably protected area.
- VSDs are dust sensitive; an appropriate dust filter needs to be installed when operating in dusty conditions.
- Full energy saving gains will be achieved when harmonic filter protections and components are properly installed and tested.
- Regular maintenance of VSDs and associated motors is essential to maintain energy savings - VSDs can become inefficient over time if they aren't adequately maintained.
- Preventive maintenance is always less expensive than correcting faults and having unanticipated breakdowns - opt for a maintenance contract with a reputable supplier to ensure that the VSDs in your hotel are kept in optimal condition

Important to know

- Some older motor designs may not have enough electrical insulation in their windings to withstand the high voltages that can occur with VSDs - they must be checked to determine whether they are suitable for VSD controls.
- In some applications, mainly in 90kW motors and higher - or where high switching frequencies are used - there is a risk of stray electrical currents being induced in motors, which can damage bearings.
- VSDs can increase harmonics in the electricity supply, which disturb the sine curve of the alternating current and cause motors to run warmer than what they are designed for, reducing their life expectancy. Harmonics can also decrease the life expectancy of computers and negatively influence the operation and accuracy of electronic measuring devices. The appropriate harmonic filters and chokes must therefore be installed, along with the VSD, to filter out the harmonics and protect your equipment.
- Motors operating under VSD control tend to run a little warmer than motors directly connected to the electricity supply; alternative methods of cooling may be required. The threshold for additional cooling will depend on the installation - in some applications motors may be de-rated to ensure adequate cooling. The reason for that is that an electric motor is equipped with a fan to cool it down. If the speed is lowered to below the specifications of the manufacturer, overheating may occur and additional fans or ventilation might be required.
- If you have a power factor correction capacitor installed, remove it before installing a VSD.

Safety considerations

- VSDs contain Electrostatic Discharge (ESD) sensitive parts and assemblies.
- Static control precautions are required when installing, testing, servicing or repairing VSDs.
- Component damage may result if ESD procedures are not followed - allow VSD capacitors to discharge for approximately five minutes before starting with work or an inspection.
- The enclosure housing for the VSD must be large enough to allow for sufficient ventilation.
- Earthing is critical: both the motor and the drive must be earthed according to installation guidelines

Investing in the correct VSDs for your hotel's HVAC system and regularly maintaining motor drives will ensure optimal energy efficiency.

Case study – Hotel Verde, Cape Town

The establishment's brief to its HVAC supplier was clear:

- Extremely energy efficient heating, ventilation and air-conditioning that meet and exceed guests' expectations and staff comfort.
- A durable, flexible and adjustable system that uses no ammonia or CFC gases.
- Intuitive, user-friendly control and comfortable conditions via pre-conditioned air to eliminate the 'need' for individual room air conditioning.
- HVAC equipment that switches off via key card readers or occupancy sensors.
- LEED NC 2009 minimum requirements had to be met.
- The minimum requirements for the energy-efficient design of buildings, except low-rise residential buildings, as set by the standard of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE Standard 90.1 -2007), had to be exceeded by 30%.

Moreover, the viability of a geothermal field had to be investigated.

Hotel Verde's stance was to first of all minimise their heating and cooling load:

- This was done by creating a well-insulated, airtight building and by installing shading and double glazed performance windows to minimise solar heat gain.
- Energy efficient lighting and electrical equipment were installed throughout.
- Unnecessary equipment was switched off.

The follow-on strategy was to cover the remaining heating and cooling load in the building as energy efficiently and effectively as possible whilst still providing a comfortable indoor environment for guests and staff.

- Over and above that, Hotel Verde educates staff and guests - as an example, guests are incentivised to refrain from using their room air-conditioning over and above the pre-conditioned fresh air, which is reticulated to all bedrooms from central systems.

Geothermal field

The next step was installing a geothermal field made up of 100 boreholes approximately 70m deep, each containing a HDPE U-bend pipe coupled together into six headers that access the constant ground temperature of approximately 19,4°C.

The ground temperature below the Hotel Verde site is a constant 19°C throughout the year while the outdoor temperatures range from about 3°C on a cold winter morning to 35°C on a hot summer day.

The system also includes:

- Variable Speed Drives (VSDs) on pumps and fans;
- Ground source heat pumps;
- Inverter-type fan coil units (FCU); and
- Intelligent control to switch off unoccupied zones.

The 100 holes and over 11,3 km of vertical and 1,1 km of horizontal pipes connecting the headers are all out of sight and protected under the hotel basement's surface bed - the only evidence is the 14 sub-header pipes penetrating through the basement floor slab.
Extensive pressure testing was done to ensure the pipe network is leak-free.

Utilising this system, Hotel Verde anticipates reducing its overall energy bill by at least 25%.

To further illustrate the benefit of the hotel's ground source system:

- In summer, when cooling loads outweigh heating loads and ambient temperatures are often 30°C, the system's ground source heat pumps - using the 19,4°C underground temperature as a heat sink - have to work significantly less than using dry coolers to generate cold water for cooling. No water is consumed for evaporative cooling.
- Similarly, in winter, when heating loads are dominant and the ambient temperatures are 10°C, the system accesses the constant 19,4°C ground temperature for efficient heating.

Challenges

One of the main challenges was designing a system that tracks guests' in-room air conditioning usage in order to automatically switch this off when the room was no longer occupied.

- This was achieved by having the controllers of the air conditioning unit reprogrammed so that they pick up when a key card is inserted and when the air conditioning is switched on – this information is then relayed to the hotel's building management system.

Awards

The Green Building Council of South Africa (GBCSA) awarded Hotel Verde a 6-Star rating in June 2015 - the highest accolade and a first for a hotel in South Africa - after having scored 82 points in the Green Star SA Existing Building Performance tool. The rating is valid for a period of 3 years to ensure the hotel is continually operated according to stringent efficiency and sustainability targets.

Only a handful of South African buildings have achieved a 6-Star rating, the highest certification achievable, and an acknowledgment of world leadership in environmentally friendly building operations and management. The aim of a green building is to use resources more efficiently and address climate change, whilst creating healthier and more productive environments for people to live and work in.

Having celebrated its 2nd birthday in August 2015, Hotel Verde's other recent accolades and achievements include:

- Being awarded a second LEED® Platinum Green Building Certification by the United States Green Building Council (USGBC), making Hotel Verde the first hotel globally to achieve double platinum certification for LEED® (Leadership in Energy and Environmental Design).
- The first platinum certification was awarded in the New Construction in the Green Building Design & Construction category in May 2014, which established Hotel Verde as one of only six hotels in the world - and the only one in Africa - to receive this accolade at the time.
- The second and most recent platinum certification was awarded in the Existing Building Operations & Maintenance category, giving Hotel Verde double platinum status and proving beyond any doubt that it is Africa's greenest hotel.
- Being awarded Green Hotelier of 2015, Africa and the Middle East, in the International Tourism Partnership's Green Hotelier Awards 2015.
- And, being voted Top 1% by Travelers' Choice on TripAdvisor in 2015.

Eskom's Energy Advisors are on standby to assist you.

Eskom's national Advisory Service can help to locate VSD suppliers and HVAC system specialists. The team can also advise hotels on:

- **Reducing energy usage**
- **Doing walk-through energy use assessments to identify energy usage patterns, energy needs, areas of energy wastage and energy saving opportunities**
- **Improving the energy efficiency of operations and electrical systems and processes**
- **Prioritising maintenance as an important contributor to reducing energy usage**
- **Finding SANAS approved energy savings Measurement & Verification Authorities.**

Advisors also help identify funding opportunities for energy efficiency projects.

Call 08600 37566, leave your name and number and an Eskom Energy Advisor will contact you - you can also ask for a specific advisor to contact you.

Alternatively, email an enquiry to AdvisoryService@eskom.co.za

Visit www.eskom.co.za/idm for more information.

Credits:

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