CASE STUDY 03/03

Sea lions
trigger Auckland Zoo's energy savings

PHOTO: AUCKLAND ZOO.

The five Californian sea lions at Auckland Zoo have been in their temperature-controlled aquatic park for two years and have proved a hit with visitors. They've also contributed – unwittingly – to a 30% reduction in the zoo's energy consumption.

WHEN ALARM BELLS RANG ABOUT THE SEA LION FACILITIES' ENERGY USE, AN ENERGY AUDIT UNCOVERED INEFFICIENCIES IN PUMPS AND A POWER FACTOR PROBLEM THAT SENT COSTS SKY-HIGH. THE REMEDIES LED TO FAR-REACHING ENERGY MANAGEMENT IMPROVEMENTS.

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"The total investment for the project was $31,350. The zoo is now enjoying savings of $73,830 per annum."

Andrew James – Auckland Zoo asset manager

Sea lions and Auckland's temperate climate are not a natural mix. Before they opened the Bluebird Sea Lion & Penguin Shores exhibit, the zoo's management team knew it would take a lot of energy to keep the 'manufactured' seawater at a suitably frigid temperature. But they weren't prepared for a whopping $62,000 increase in the annual energy budget.

"Nothing in the facility's design hinted at this kind of energy use," says the zoo's asset manager, Andrew James, "and it presented a huge problem. Our entire electrical feed (from network company Vector) is delivered via a 300 kVA transformer, and when consumption began climbing to 320 kVA, we knew we had to do something. Apart from the additional $62,000 cost, we couldn't risk blowing the transformer."

Boosting the zoo's network connection to 500 kVA was an option, James concedes, but would require a major upgrade to the main switchboard and result in higher network charges. "That simply wasn't affordable. We had to cut consumption, but we weren't sure how."

That uncertainty led the zoo to commission Auckland consulting company Energy Solution Providers Ltd (ESP) to investigate the sea lion facility's energy use, followed by an analysis of the zoo's overall energy consumption.

ESP began with a comparison of energy usage patterns "before the increase" and "after the increase", collecting data from electronic meters all around the zoo. "While the analysis confirmed that the sea lion park was directly responsible for the increased energy consumption," says ESP managing director Jeremy Allen, "it also identified a serious power factor problem. It was averaging around 0.90 and costing the zoo an additional $2300 in annual demand charges.

"Large motors have an inherently poor power factor and typically run at around 0.80," he points out. "When you have a lot of them, as in the zoo's situation, it can quickly magnify into a serious problem. Improving the power factor to 0.95 or better would reduce both the demand charges and the network capacity requirements."

Cutting costs

To maintain its complex, artificially-created environment, the sea lion exhibit features a variety of cooling, pumping, filtering and injection systems, running 24 hours a day, seven days a week. The water is mixed with salt, treated with ozone (for disinfecting) and is continuously filtered. There is a greater requirement for constant water flow and filtering during the day – when the animals are active – than there is at night.

The major loads within the system are three fixed-speed filter pumps (11 kW each) and two fixed-speed ozone injection pumps (7.5 kW each). Together, they increased the zoo's electricity demand by around 70 kVA.

"An obvious problem," says Allen, "was that the variable filtration and water flow requirements were being met by automatic control valves on the pump outlets – leaving the motors running flat out all the time." The solution was the installation of variable speed drives to regulate the filtration motors according to flow rate requirements. Three 11 kW Danfoss drives were fitted by Auckland's Water System Treatment Specialists Ltd, and the immediate benefit, says James, provided a six-month payback on the units.

The energy savings were complemented by adding insulation to the park's piping infrastructure. The park's water has to be maintained at around 18°C, and refrigeration technology – a number of heat exchange pumps – was running 24 hours a day to offset heat gained through the piping. Insulation lowered the pumps' duty cycle considerably.

"The energy savings were complemented by adding insulation to the park's piping infrastructure."

Core strategy

Better management of pumps quickly became a core strategy for the zoo. Turning pumps off (or reducing their cycle) at night when animals were inactive was applied throughout the complex.

"Improving the efficiency of pumps feeding moats and various water features has contributed to a 29% saving on mains water usage over the past 12 months," says James. "We have restricted the times we have water features running, and pumps are all on timers so that they're only in use when absolutely necessary."

With pumps running more efficiently, ESP shifted its focus to the zoo's power factor problem. "We installed a 45 kVAr automatic power factor correction unit at the main switchboard," says Allen, "and the effect was immediate – the power factor climbed from its average of around 0.90 to 0.99."

Collectively, the variable speed drives, the pump management strategy and the power factor correction have cut the zoo's energy consumption from an average of around 307 kVA to 285 kVA. The total investment for the project was $31,350. James confirms that the zoo is now enjoying savings of $73, 830 a year – and an overall payback period of less than six months.

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1 THREE **DANFOSS VARIABLE SPEED DRIVES** REGULATE THE **FILTRATION PUMP MOTORS**.
2 A COMBINATION OF **WALL-MOUNTED MOTION AND TEMPERATURE SENSORS** CONTROL THE **OVERHEAD RADIANT HEATERS**. THE TECHNOLOGY IS BEING TRIALLED IN THE **RHINO ENCLOSURE**, AND THE **RESULTS ARE VERY ENCOURAGING**.
3 WHERE **CONTROL VALVES** USED TO REGULATE THE FLOW OF WATER THROUGH THE SEA LION PARK, **VARIABLE SPEED DRIVES NOW ADJUST THE OUTPUT** OF **THREE 11 KW ELECTRIC MOTORS** – A MOVE THAT HAS HELPED THE ZOO REALISE A **30% SAVING IN ENERGY CONSUMPTION**. PHOTOS BY LAWRENCE SCHÄFFLER.

Heaters

Energy savings strategies are continuing at the zoo. ESP's original walk-through survey identified the zoo's heating technology as an 'energy-excessive' culprit. "Overhead radiant heating systems are used in a number of the animal enclosures," says Allen.

"Most heaters run from 7.00 pm to 7.00 am, six months of the year, irrespective of climate conditions. In addition, we discovered that some of the timers controlling their operation were not functioning properly."

ESP is trialling an alternative system for controlling the radiant heaters in the rhino enclosure, and James says the initial results look very encouraging. "We're testing a dual-system technique – a combination of movement and temperature sensors. Both are required because when the animals settle down, they can remain motionless for quite a while. That fools the motion sensors, so the temperature sensors are needed to activate the heater." Once the system is perfected, it will be applied to enclosures throughout the zoo.

4 THE **POWER FACTOR CORRECTION UNIT** FITTED TO THE MAIN SWITCH-BOARD HAS IMPROVED THE **ZOO'S POWER FACTOR FROM 0.90 TO 0.99**.

Monitoring consumption

The zoo has also recently installed a web-based LiveData system for monitoring daily electricity and water consumption. The technology monitors 10 electrical feeds and numerous water flow points at various parts of the zoo, and as a report-based system, automatically generates a 'warning' e-mail to James when a problem occurs. "Any of the staff can log into it, and it's particularly useful for identifying and locating areas indicating unusual consumption spikes."

LiveData, he says, has already helped to identify a number of water leaks. "The water piping network is very old and is plagued by leaks. We've managed to cut water consumption significantly with LiveData identifying those leaks."

Auckland Zoo sees further room for energy savings, and with staff buy-in, aims to achieve an additional overall 10% saving by December this year.

Says James: "Zoo staff have seen the tangible impact of an active energy management programme. ESP's investigation revealed the zoo's base load of 1.3 million kWh was costing us $120,000 annually. Any reduction in the base load translates into significant savings. And that's got to be good for the zoo, the animals and the public."

What is power factor?

Auckland Zoo has saved money by changing its power factor from 0.90 to 0.99 – what does that mean? ESP Ltd likens running a low power factor to paying for a full glass of beer but only drinking half.

Electricity users on a "demand"-basis tariff are billed for the amount of power they are supplied (kVA), not the amount they use (kW). Power factor is the ratio between the power used and the power supplied. The difference between power supplied and power used is called reactive power. If the power factor is below 1.00, users are paying for power they are not using.

Reduced power factor arises from inductive loads such as transformers, fluorescent lights and ac induction motors. Typical applications include air compressors, plastic extruders and machine tools. The inductive loads require both active power (kW), which performs the work, and reactive power (kVAr), which sustains the electromagnetic field and does no work.

If the power factor of a system is low it uses more power than it needs to do the work. This can result in excessive heat being generated, extra maintenance costs, sluggish motor operation and dim lights.

Power factor correction is achieved by adding capacitors in parallel with the motor circuits. The capacitive "leading" current is used to cancel the "lagging" inductive current. But other devices on the same switchboard, such as variable speed drives, can cause complications in the electrical current patterns, and simply installing capacitors can damage equipment. It's best to consult an expert.

CREDITS

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Web energy monitoring LiveData, available through ESP

Energy auditor accreditation

One of the main features of effective energy management programmes is the use of energy audits. The New Zealand Energy Management Association (EMA, www.ema.org.nz) operates an accreditation programme for energy auditors.

EMA members who qualify for accreditation can call themselves "accredited energy auditors". They are listed as accredited energy auditors in the EMA membership list. In August 2003 New Zealand had eight EMA Accredited Energy Auditors.

The accreditation process provides an independent, unbiased assessment of the work of an auditor who applies for accreditation.

Auckland Zoo's energy survey had a format developed by ESP and was not an energy audit of the type specified in the ASNZS 3598: 2000 Energy Auditing Standard. ESP team member Noel Mason is preparing for accreditation as an energy auditor. When he gains accreditation, ESP will add ASNZS 3598: 2000 energy audits to its services.

EECA energy audit grant scheme

The Government has established a fund to encourage organisations to undertake energy audits of their facilities and implement the subsequent audit recommendations. The grant is to part-fund the cost of energy audits.

To qualify for the grant, recipients must complete an audit and achieve energy cost savings by implementing some of the audit recommendations. The resulting energy cost savings must equate to at least 70% of those savings obtainable from implementing all highly cost-effective energy saving opportunities.

Grants, which are generally limited to $10,000 per organisation per year, are available for Level 2 audits carried out in accordance with the ASNZS 3598: 2000 Energy Auditing Standard.

Energy savings at the zoo

- Daily average usage has dropped from 4518 kWh to 3441 kWh
- Maximum demand has dropped from 320 kVA to 248 kVA
- Power factor has improved from 0.90 to 0.99