







Mercury's Trading Room in Hamilton watches over the energy harnessing of the mighty Waikato River and it's also responsible for keeping the nation's 'frequency' even. Alan Titchall pays a visit.

Three years ago Mercury moved into new premises in Hamilton overlooking the Waikato River, which it controls from Lake Taupo down through nine hydro stations on its way to the west coast.

It takes 24 hours for a body of water to travel from the Taupo control gates at the northern end of the lake to Karapiro, the last dam on the river, and a well-trained computer controller, in a 12-hour shift, is in charge of using its passage through each power station to produce the energy requirements for a lot of the country, while working the entire living river for many other social benefits.

Andrew Anderson, the trading manager at Mercury, meets me alongside the controller at the time, Julian Antoniazzi, to explain how it all works.

Armed with a mouse and keyboard Julian is constantly

monitoring a bank of computer screens and technology using sophisticated software supplied by Honeywell (see side box).

A hooter alarm, like the crash dive warning in an old submarine, blares out from one of the computer screens. What the hell is that?

It is Transpower, the body that operates the national grid, letting us know its requirements, says Andrew.

"We make offers to them on what we potentially can generate and then Transpower works out the most efficient and cheapest way to supply market energy requirements. It then sends us a dispatch, which is the hooter sound that you heard, and asks us to generate the exact megawatts it needs."

The hooter blares out again and Julian is unflustered.

"In general we get a blast on the hour and the half hour, but as the electricity load changes throughout the country a



The bee says it all

When Mighty River Power rebranded to Mercury it dropped the logo with the Mercury man and his lightning bolt and replaced it with a bee.

The bees are hard working, native to New Zealand, have wings shaped like an infinity sign to reflect the renewable nature of all of Mercury's 100 percent renewable generation, have antennae (listening to customers) and the lines around the torso are like the water reservoirs Mercury uses to operate and hold its fuel sources.



dispatch from Transpower can come through once every five minutes," he says.

On top of these requests, the controller also has to look after the national system frequency, which runs at 50 hertz to keep everything in sync and make sure your home appliances don't have an electrical meltdown.

Any movement from supply and demand makes the frequency move one way or the other, Andrew explains.

"If there is more supply than demand you will have a high frequency. If you've got more demand than supply you will have a low frequency."

If the nation's frequency gets too low you run the risk of cascade failure of the power system, he adds casually.

"So the frequency is kept very close and we operate with generators called 'frequency keepers' – their job is to alter their load for small changes in demand and supply to keep the frequency at 50 hertz."

So what is the worst thing that can happen to a controller on one of these shifts?

"More significant events include actually losing large power stations creating a big drop in supply and frequency," says Andrew.

"Then, automatically, governors on every plant around New Zealand and the river will respond and lift up generation to counter the frequency fall.

"In really large events the system operates on what's called N-1 security where Transpower will cover the single biggest generation risk to the market and carry enough power and reserves to replace that within potentially six seconds."

Comforting to know.

"Yes, very important," Andrew adds. "All the control rooms around the country are integral to the power system and there's five significant ones – us, Trustpower, Meridian, Contact and Genesis."

In charge of a river

The Waikato River features eight dams and nine hydro stations and during my visit Julian was in control of the lot in terms of generation and 'hydraulic management', or making sure the water was in the right places at the right time to generate for evening and morning peaks.

"Because the river is not actually created equal," Andrew explains, "there's bottlenecks in different stages of the flow.

"Meridian [a South Island energy generator in charge of the Waitaki power scheme] has manmade canals and they actually know exactly the volume of water in those canals.

"We manage a natural river, and the bed changes with erosion and other things so it's a constant changing beast. As we can't model flows so easily our hydro controllers have a very skilled job on their hands." Andrew says there are eight hydro controllers, all based in Hamilton, who work 12-hour shifts from 7am to 7pm in a 24/7 operation.

"I only need six to run my roster of hydro controllers but of those eight, five of them are dual trained and can trade the electricity market as well. What power a trader puts into the market, the hydro controller will deliver an hour later."

Originally from the UK, Julian tells me he trained here with Mercury where he has worked for 16 years.

"I first started on the trading desk, cut my teeth there for six years and then cross trained over a period of a year on hydro controlling," he says.

"The training is for six months but you're really learning the job for a number of years before coming up to speed."

How do you sit in front of a bank of screens for 12 hours at a time?

"The workload depends on how many people are communicating with you at any one time. It's a bit of a learned skill, and some people are better at concentrating for periods. We do have breaks and colleagues that can sit in for us."

I ask Andrew why the shift is so long?

"It's basically the best design for the health and safety of the traders. We had a look at the rosters and worked out that for the circadian rhythm and sleep patterns of the traders it's much more efficient for them to do two 12-hour day shifts and then do two 12-hour night shifts, instead of doing like five eight-hour night shifts.

"Basically, if you only do two night shifts your body clock doesn't change so therefore you can get back into a normal sleep pattern.

"If you're doing, say, a midnight to 8 o'clock shift five days in a row – your body clock changes sync and it's very hard to actually switch back into the next shift run."

Working with the weather

This country swings between wet and dry years, not as extremely as states in Australia, but our weather has a significant impact on hydro flows and generation. Mostly, generation from the bottom of the South Island flows north through the High Voltage Direct Current (HVDC) link across Cook Strait. This year, the southern dams were so dry, power had to flow south.

"This year we had the wettest on record," says Andrew.

"From January to September we've had 100 percent inflows which basically indicates it's about the wettest we've seen in 100 years of rain for a period of nine months. "Which means we have been 'volume' focused in terms of moving river volume as we only have limited storage in Lake Taupo.

"We only have a 1.4 metre range with the lake and we use that range depending on the inflows. Between five and seven times a year we'll cycle that 1.4 metre range in Taupo.

"Obviously that's not top to bottom because as we are generating more rain goes into the lake so we tend to bounce around a bit."

The big reservoir

Andrew says in terms of generation storage, Lake Taupo contains 600 gigawatt hours worth of electricity storage, while the Waikato River contains 22 gigawatt hours of storage.

Of this total river storage capacity, 18 gigawatt hours are held in Lake Ohakuri, one of the first lakes on the river.

"The intermediary lakes don't have massive amount of storage, but they are very consistent," says Andrew.

"Under our consents we have to keep a constant flow out of Taupo, and we have 50 cubic metres per second coming out of the lake to feed the river. At the bottom we need to have 148 cubic metres per second coming out of Karapiro.

"I know we have a little bit of a mismatch there, with 50 in the top and 148 out the bottom, but down the side of the river are tributaries that feed in the extra 100 cubic metres.

"This 148 cubic metres per second has got a bit to do with the cooling requirements of the Huntly power station, in that we can't have the river too low, otherwise the power station (run by Genesis Energy) will have cooling issues on its thermal units. And that's part of our resource consent.

"It's also to keep the river being a 'river'. If we didn't have the minimum flow out of Karapiro the river could become too empty. Which obviously is not good, so the river is always maintained as a river and will always keep flowing."

Lake Taupo's 600 gigawatt hours worth of electricity storage represents around three months of market power, adds Andrew.

"So, as a storage pond, this is not a huge resource, and we have to focus on potential dry periods, and making sure we've got enough water to get through those dry periods.

"January to May is generally the driest period for us. We tend to start January with Lake Taupo reasonably full just in case we actually do go through a dry period, and we have enough fuel to carry us through to the start of winter. In general in May it starts to rain a lot and we get to refill the tank."

The technology

Before 1993 the company's hydro stations were staffed and operated 24/7. In 1993 it adopted the Landis+gyr SCADA system by which it could control all hydro operations from one site, based in Hamilton.

In 2011 the SCADA system was upgraded to a Honeywell SCADA system called Experion. The hydro controller uses Experion to manage eight dams, nine power stations and 39 generating units as well as the

ancillary equipment and security systems.

There are over 80,000 alarmed variables across the hydro system, which feed into the Experion system.

The system can be run from Hamilton or any of the hydro sites along the river chain. In disaster recovery mode the system can also be run off laptops if, and when, required.

Social responsibility

Andrew says Mercury is mindful that the Waikato is a river enjoyed by communities along its length.

"We get around 60 flow and level requests a year from different stakeholders along the river asking for different lake levels.

"Karapiro is a popular spot for rowing, water skiing, hydro planes, other events, and triathlons and from October through till March and April we get flow and level requests every weekend so people can undertake their activities safely.

"In general, we meet every single one of those requests. If it doesn't pose a health and safety threat to our plant, or to our people, we will actually go out of our way to make sure that happens."

The exception, Andrew adds, is if someone is to make a commercial outcome of it.

"For example, for the filming of *The Hobbit* at Aratiatia, when they asked for an extra spill so they could film the dwarves going down the river in barrels, they were charged.

"But most of the requests come from non-commercial entities like Karapiro Rowing or New Zealand Rowing, and water skiers."

Waiting for the unexpected

With 39 generating units down the river anything can stop

working, says Andrew, keeping controllers on their toes.

"We need to take them out for maintenance from time to time which throws a cat amongst the pigeons in regards to the hydraulic management of the river.

"So, no two days are the same for a hydro controller when he or she sits down because there is a chance they might suddenly not have a plant to use. They also have to be mindful not to overfill any lake, otherwise we will be forced to spill water and we don't like spilling water because it is energy down the drain.

"Which means we do have to be very forward looking in regards to outage planning. We aim to have full capacity over winter and get stuck into our maintenance over our summer months.

"But sometimes a plant fails in the middle of winter. So it can appear to be quite sedate at times but it can change at the drop of a hat. A controller can be sitting here trucking along, everything happening happily, and then we lose a plant and their whole day changes and they've got to rearrange their hydraulic views and how they manage the river.

"This is why, when it comes to the type of people we look for in a hydro controller, we look for very calm level-headed people who can make decisions very quickly and calmly under pressure." WNZ