River power
A hydro power station in your backyard

Dr Catriona McLeod reports on a project harnessing a large renewable resource, at a smaller scale, in Tasmania.

↑ Humboldt River power station and tailrace with the river in flood.

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IN SOUTH Tasmania, Nigel and Josh Tomlin, founders of River Power Tasmania, have designed, and custom built, a hydroelectric generator. This might not seem so unusual as the market is awash with domestic and micro-generators. These small-scale operations are designed to power one domestic site; however, even Nigel's first 'backyard' working prototype, built several years ago, powers about 30 houses, near his property at Ellendale.

The prototype takes water from the Jones River, which runs through the Tomlin's property. This small generator generates about 80 megawatt hours per year and is powered by water falling 30 metres along 500 metres of pipeline.

The newer, second and larger hydroelectric generator is on the Humboldt River, which starts below Tyenna peak, in Mt Field National Park, at an elevation of 896 m, and ends at an elevation of 248 m. The Humboldt River drops approximately 648 m over 10.3 km. The fall and water content of this river make it ideal for a hydro scheme.

The generator captures water in the last 2 km of river, where it flows through forested areas used for industrial-scale softwood plantations; over the last 2 km it falls 98 m vertically. It demonstrates the efficiency of physics: the energy of falling water is enormously powerful in terms of generating electricity, even at a smaller-than-commercial scale. This new system is expected to generate 2.2 gigawatt-hours per year.

A bit of history

Of course, this 'technology' is not new. Water mills have operated since the Roman Empire. The remains of two mills, found in modern-day Tunisia, date to the late 3rd or early 4th century AD. Apart from the sail, the water mill is the earliest example of a machine harnessing natural forces to replace human physical effort. In the original mills, the energy of the falling water was directly diverted to the task; however, their main shortcoming was size, which limited the flow rate and therefore the amount of energy that could be harnessed.

The advent of the Industrial Revolution changed the 'course', so to speak, of the water wheel. With developments in scientific principles and methods, the water wheel was greatly improved to include a swirl component of the water, which passed energy to a spinning rotor. Extensive use of new materials and manufacturing methods developed at the time also engendered a new robustness, and the intake could be increased.

Conversely, the additional component of a swirling motion meant the turbine could be smaller than a water wheel of the same power. The turbine could process more water by spinning faster and could harness a much

↑ Turgo impulse turbine.

Some features of a run-of-river system

- Hydro without the dam
- Doesn't affect water quality
- Does divert water for a stretch of the river, but environmental baselines have been set and are being monitored
- Can be constructed from off-the-shelf or recycled materials, so spare parts are easier and cheaper to obtain
- Materials used in construction can be largely recycled
- Low operating costs, minimal maintenance
- Works with the seasons: when power for heating is required, water is plentiful.

greater 'head'; later, 'impulse' turbines were developed which didn't incorporate the swirling motion.

A shift to domestic-scale

More recent developments in this technology have seen a move away from large dam infrastructure to more domestically scaled turbines—truly an economy of scale.

The Humboldt River hydroelectric generator is housed in a cabin constructed from river stones removed from the trench in which the water pipeline is laid. The turbine is set on 75 cubic metres of concrete and, because of its construction, causes very little vibration. Noise is insulated by the stone/concrete walls and heat is vented through an aperture in the roof. The generator is embedded in the turbine system. Energy is generated at 415 volts but the local distribution grid is 11,000 volts, hence the need for a transformer. As the system is connected to the national grid, no energy storage is required.

Turbine technology

Manufactured in Australia by Pentair Southern Cross, the Turgo impulse turbine installed by the Tomlins is a medium-to-high head turbine. It's designed for 'run of river' schemes as it can tolerate some so-called 'dirty water' (although the water entering this system is incredibly clean) and has good efficiency over a wide flow range. It's also designed for minimal maintenance; this is vital to the Tomlins as they also run a large, diverse farm in the area. Monitoring can be done remotely via the Citect program, with error alarms sent out via SMS.

This model can be manufactured in a range of materials to suit the customer's requirements. Here, Nigel's 30-plus years in the hydroelectric industry—dreaming on the job of his own generators—meant he was very clear about how he wanted his machines to be configured. He notes the system is actually incredibly simple: an induction generator converts the water's energy, much like a large washing machine motor being run in reverse.

Hurdles

The hurdles to construct this turbine have, however, been anything but simple. As mini-hydro projects are rare, there are no local precendents for the authorities to observe, and no specialists who properly understand the project. For example, the water management board required the installation of expensive monitoring equipment on the assumption the tailrace would be a trench dug into the earth. However, as the tailrace has been constructed from concrete to the river's edge, to avoid creating any muddy turbidity, the Tomlins' are arranging to have this requirement lifted. The outwardly tapering tailrace also slows the water's velocity as it rejoins the river, some two and a half kilometres downstream from its point of diversion.

Around 48% of the river's flow will be diverted, and returned as clean as it enters the pipeline. Baseline levels of micro flora, micro fauna and water quality have been taken by consultants, for ongoing monitoring once the system is in operation. The project has required close liaison with the local forestry landowner, Norske Skog Boyer Mills, and other local and state stakeholders.

River Power Tasmania received an initial $700,000 grant through Ausindustry's Clean Technology Innovation program, funded by carbon tax revenue. The program was pivotal in enabling the Tomlins to commercialise their mini-hydro innovations, but the future of the program is now uncertain.

With the loss of the carbon tax, the incentive for energy purchasers to pay a decent rate for energy from small-scale suppliers such as the Tomlins is also reduced. Josh notes the future looks grim. "Changes to the carbon tax essentially make carbon-emitting power cheaper and renewable energy dearer. The scrapping of clean energy programs also limits the government support for other projects to be developed."

Operations started in late June and it's operating well, albeit with a 'surprise' of additional tariffs charged by the network for the transport of the power. The project has met the design expectations—in two of the winter months it has generated 25% of estimated annual output and has coped with the largest flood in 20 years.

Although this project was a huge financial risk due to the engineering challenges, the Tomlins are proud to have achieved this prototype which will be an example for hydropower working in sync with the environment.

They hope their system could be adopted nationwide, wherever there is good water flow, and some government incentive or support. Hydro power is the most advanced and mature of the renewable energy technologies; yet it is also one of the simplest, if market forces and bureaucratic red tape don't constrain it to being viable only for the big producers. ✱

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