[Buyer's guide]

Tap your onsite power resources

The last time we looked at the micro-hydro market was in *ReNew 72*, so we thought it was about time we looked at them again to see what's new

While there are not many hydro turbine manufacturers in Australia, there is still an excellent range of turbines available in the under-20 kilowatt class, in both AC and DC output models.

Why buy a micro-hydro?

The potential energy stored in water situated above sea level is considerable. You just need to look at the deep pools often found below large waterfalls or how the rocks in a creek are worn smooth, to be awed by its power.

Harnessing the power of water is by no means a new concept. Waterwheels have been used for centuries for milling, grinding and other types of mechanical work. Turbines came in to play to replace waterwheels and to power electric generators in remote areas in the mid 19th century.

Nowadays, water turbines are increasingly being used in developing countries due to their relatively low cost, comparatively simple maintenance, clean renewable nature and the abundance of suitable hydro sites. With environmental awareness increasing, the push is away from big centralised power sources and back towards energy systems that use local natural resources.

All that aside, if you have a remote property and need to supply reliable power, then in some cases a micro-hydro turbine will be the best option.

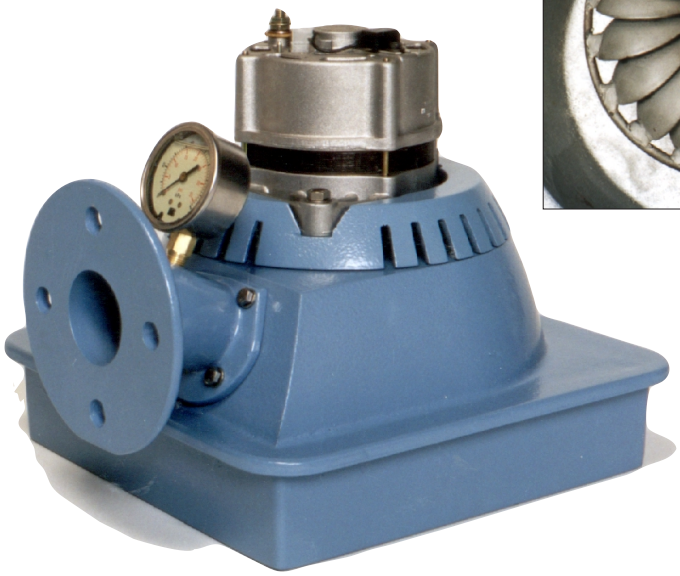
Turbine types and siting

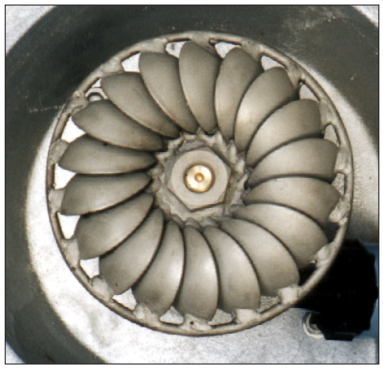
The basic layout of most micro-hydro systems involves a turbine, mounted at some low point on the creek or river, being fed by pipes running from a much higher point in the water source. The weight of water in the pipes causes a relatively high water pressure at the turbine end of the pipe, thus providing a means of driving the turbine. To get an idea of the forces involved, try aiming the jet from an ordinary garden hose at your hand. You will feel the force of the water striking your hand and being deflected. This is how many turbines work, in a round-about way.

Flow rate (in litres per second of water flowing through the unit) and head (the vertical height that the water falls) are the two major factors governing the amount of power available from a site. Several different types of turbines have been developed to cope with a variety of situations, such as a high head with a low flow rate, or a low head with a high flow rate.

The turbines available generally fall into one of two categories—impulse turbines or reaction turbines.

The Platypus Power range is available in DC battery charging and AC output designs. Here you can see a DC output M1-125 unit, as well as the stainless steel hybrid runner (right).





Impulse turbines

Examples of impulse turbines include Pelton, Turgo and Banki Crossflow. The water is directed through one or more nozzles and onto the 'runner' (turbine wheel). This rotates above the level of the water source, and the water falls below the turbine to the tail water, usually flowing from there back into the creek.

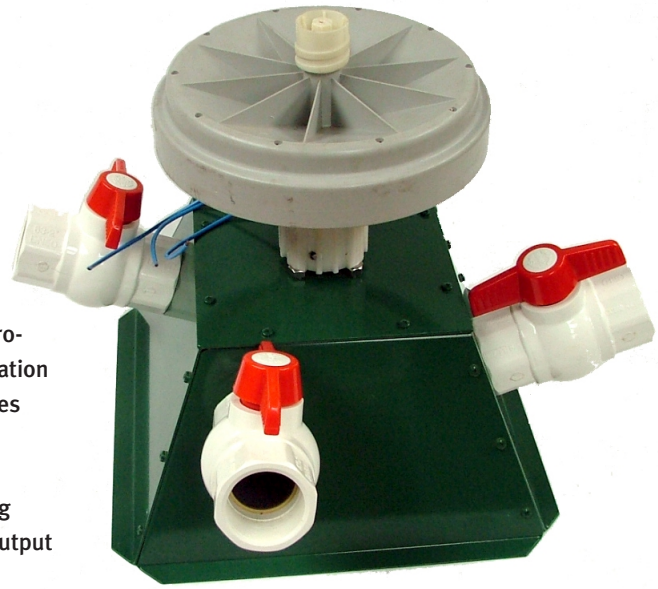
This turbine won't function submerged in water, so it must be situated above the maximum flood level that the water source may reach. This often leads to significant loss of head, which is one reason why this sort of turbine isn't used in low-head applications.

The Pelton wheel is probably the best known and most commonly used of the

impulse turbines. The Turgo is very similar, but has a slightly higher efficiency. Both types run at relatively high speeds, allowing them to be directly coupled to a high-speed generator, but Turgos will spin at a greater rpm for the same size jet diameter.

Turgo turbines can also be arranged to spin at half speed, allowing efficient operation at low heads.

The Crossflow turbine is somewhat different. It uses a cylindrical type rotor through which the water passes twice. It can be used with virtually any head (1 to 200 metres). These systems are good for water pumping, and the Planetary Power machines are sometimes used this way.



A new player in the micro-hydro market, EcoInnovation from New Zealand, makes this turbine that uses a Turgo runner to drive a Fisher & Paykel washing machine motor. Power output is up to 1kW.

Reaction turbines

This class of turbine includes the Francis and Kaplan types. The blades on these turbines are submerged in the water itself. As the water flows over them, lift forces are created, similar to the way lift is generated by the wings of an aircraft. These forces cause the turbine blades to rotate. The water exiting the turbine is discharged via a draft tube which creates a negative pressure on that side of the turbine. This means that the fall of water after the turbine can also be included in the net head, which is very significant if there is not a lot of head to begin with. The Francis turbines are the most efficient of the reaction turbines but are generally more expensive.

A novel form of reaction turbine can be seen on the next page—the Aquair generator is designed to be fully submerged in a water flow to generate electricity.

Reaction turbines tend to be bigger and are more expensive than impulse types, so if you're lucky enough to have a choice between a high head, low flow site or a low head, high flow site it's best economically to opt for the former.

Other things to consider if you're thinking about installing a micro-hydro system are generators, load regulation, civil works and electrical work.

AC or DC?

There are two common systems available—DC, or battery-charging turbines, and AC turbines.

The DC turbines are designed to feed their power into a battery bank for use at a later stage. These are well suited to sites that may not flow all of the time, but do have regular or seasonal flows. Some installations use micro-hydro turbines to provide power during the winter months, when water is most abundant, and rely on other power sources, such as the sun, during the hotter, dry part of the year.

If you have a good flow of water all year round, then an AC turbine may be the best option. These produce power at 240 volts AC, just like mains power, so you can draw power from the turbine directly, without the need for batteries, inverters and the like. An excellent example of this type of system is the 13kW turbine at Stevensons Falls, near Marysville in Victoria. This turbine supplies power directly to lights used to illuminate the falls at night.

The disadvantage with this system is that you are limited in the amount of instantaneous power you can draw from the turbine. For example, if you have a 1.2kW system, then that is the most power you can draw from the turbine. Loads larger than this will need to be powered from some other source. You can, of course, use an AC turbine to charge a battery bank, just like a DC turbine.

Power control

Load regulation of most turbines usually occurs by 'dumping' the excess energy into some form of load. This is often a series of light globes or heating elements, such as in a hot water system. Regulation is required to avoid large voltage fluctuations, and to keep the turbine running at a near-constant speed. There are several types of regulation systems, from simple on/off switching to variable load dumping, where the load dump connected to the turbine varies inversely proportionate to the main load.

As an example, if you have a 1kW tur-

bine, and you are using 200 watts from it, then the other 800 watts will be fed into the load dump. If your load increases to 650 watts, then the excess 350 watts will be dumped. This system can be achieved in several ways, but a commonly used method is to switch in load dump elements of varying sizes in the right combinations to form a load dump of the correct size.

A novel approach to regulation has been taken by Tamar. It has developed a water economiser that varies the water flow through the turbine, depending on the load. This reduces the power produced by the turbine, reducing the power dissipated by the dump loads. This system suits sites where the flow is intermittent or where water storage in a weir or dam is used.

Tamar has another device, 'Automatic Start' which actually stops the turbine if the load falls below 40 watts. When a load of 40 watts or greater is applied the machine automatically starts in a few seconds. It is designed to help the system cope with intermittent power requirements such as a refrigerator.

Civil works

This refers to the other parts of the system, including head (penstock) and tail (draft) pipes, dams and other parts of the water supply system. Civil works may involve as little as a couple of hundred metres of plastic piping with a screen filter at the collection point, right through to construction of a large weir or dam, along with the other associated parts. These include trash racks, which deflect solid material from entering the feed pipe, control valves, and even flood control systems. Be sure not to underestimate the effect the civil works will have on the cost of the system—it can become very expensive if you can't do it yourself.

The Aquair UW is designed to be submerged in a fast flowing river or stream and will generate up to 100 watts.

Some councils charge a fee for water taken from a stream, even if it is returned at a later stage. Check with your council before planning a system.

Buying a turbine

This can be a complex process, as you have to determine head, flow rate at the selected site, ease of access, type and amount of power required from the turbine and possible environmental disruption to the area. Remember that to minimise the effect you have on the local ecosystem, you must not divert all of the water from the source to run through your system. If you are unsure, set yourself a limit of, say, 50 per cent of the total flow at the lowest flow rate period, usually during summer or the dry season.

Once you have these details worked out, you can then start thinking about the type of turbine you want. See the table at the end of this article for the turbine most suitable for your requirements. If more than one turbine seems ideal, then you will have to look at other factors, including price and maintenance requirements, though you should also look at these initially. It all depends on your priorities.

Other turbines

We have covered the most common commercially available turbine types, but there are others you may want to consider. These are mainly used in direct flow applications, such as waterwheels.

Rainbow Power Company's 300 watt Pelton turbine.

Waterwheels are usually undershot, where the lower paddles of the wheel are simply placed in the flow of a river or stream, or an overshot wheel, where waterflow is directed from the source to the top of the wheel. The weight of the water in the wheel 'buckets' pulls the wheel around.

Floods can be a problem for undershot wheels, as they need to be placed in the water source directly, but overshot wheels can be located in safer areas and have water diverted to them.

While there are no commercial manufacturers of waterwheels that we know of, they are quite a simple device to make. There have been several designs for waterwheels published in previous issues of *ReNew*. If you are of the do-it-yourself persuasion and have a useful creek with good flow but little head (common on small properties), then a waterwheel may be the best option—though for electricity generation some form of gearing up is needed.

Brand (Made in)	Model	Rotor type	Rotor material	Voltage	Power (kW)	Head range (metres)	Flow range (litres/sec)	Generator type	Regulation	Warranty (years)	RRP Inc GST ($)	Comments	Company details
Aquair (United Kingdom)	Aquair UW	Reaction		12, 24VDC	0.1	NA	NA	Permanent magnet	NA	2	$2,080	Immersion turbine suitable for medium to fast flowing streams and rivers	Energy Today PO Box 340, Botany NSW 2019 ph:(02) 9700 0960, fax:(02) 9700 0964 energytoday@quirks.com.au www.quirks.com.au
EcoInnovation (New Zealand)	Turgo	Turgo	Stainless steel	12, 24, 48VDC or 240 to 500VAC with transformer/rectifier pack to 24 or 48VDC	Up to 1000 watt	3 to 20	8 to 25. For lower flows use our Pelton turbine	Rewired Smart Drive permanent magnet	External voltage regulator and diversion load sold separately	2yrs full warranty. From 2 to 5yrs will repair for no more than $100 per part	From $1,100 delivered, $1,500 with regulator and load	Suitable for sites as low as 3m of head. Uses Smart Drive parts that are cost effective and plentiful. On low head sites turbine can only do 300-500 watts. Conversion efficiency on low head site is 40% water to wire	EcoInnovation 671 Kent Rd, RD1 New Plymouth New Zealand ph:(06) 752 2765, fax:(06) 752 2768 www.ecoinn.co.nz ecoinn@paradise.net.nz
	Pelton	Pelton	Plastic. Removable spoons. Spare set provided			10 to 100	0.25 to 8. For higher flows use our Turgo turbine					Suitable for heads as low as 10m. Uses common Smart Drive parts that are cost effective and plentiful. Conversion efficiency is 45-54% water to wire depending upon site parameters, power output and voltage of unit	
Pelena Energy (Australia)	PCFT-1 (1 nozzle)	Crossflow	Stainless Steel	See comments	2 to 87	4 to 50	80 to 250	Any - see notes	Electronic, grid connected or manual	1	POA	Generator options are DC, AC (synchronous stand-alone), AC (asynchronous/induction - grid connected) 1 or 3 phase 50/60Hz. Units have standardised bearings, seals and belts (if needed). 95% stainless steel	Pelena Energy ph:(03) 4342 6520 www.pelena.com.au
	PCFT-2 (2 nozzle)				2 to 175		170 to 500						
	PCFT-3 (3 nozzle)				10 to 250		260 to 730						
	PPT-1 (1 nozzle)	Pelton	Stainless steel with replaceable cast iron buckets		2 to 150	25 to 140	12 to 125						
	PPT-2 (2 nozzle)				2 to 250		12 to 225						
Platypus Power (Australia)	PM1000	Hybrid impulse	Stainless	12, 24, 48VDC	0.75	8 to 100	0.5 to 15	Permanent magnet	Plat 20/40	2	$3,878		Platypus Power PO Box 538 Smithfield QLD 4878 ph:(07) 4055 8057 plapower@netc.net.au www.platypuspower.com.au
	U3000			12, 24, 48, 110VDC	1	4 to 50	1 to 30		Plat 20/40		$5,276	Ideal for long transmission	
	Q2/150			240VAC	1.8	20 to 80	3 to 12	Induction	SG104		$5,325		
	Q3/150				2.3	20 to 90	3 to 15		SG104		$6,820		
	Q4/150				3.2	20 to 90	5 to 45		SG104		$8,140		
	PP5/150				5	25 to 110	7 to 48		SG104		$9,355		
	PP7/150				7	25 to 110	7 to 55		SG104		$11,720		
	PP10/200				10	40 to 110	16 to 60		SG104		$12,870		
Rainbow Hydro (Australia)	HYD-200	Pelton	Epoxy compound	12 or 24VDC	0.3	7 to 100	0.2 to 100	3 phase induction	PL20	1	$3,300	Regulator included	Rainbow Power Company PO Box 240, Nimbin NSW 2480 www.rpc.com.au
Stream Engine (Canada)	HYD-060	Turgo	Bronze	12, 24, 48VDC	1.9	5 to 150	1 to 9	Permanent magnet	PL20/40	1	$3,300	Regulator extra	Rainbow Power Company PO Box 240, Nimbin NSW 2480 www.rpc.com.au
Tyco Tamar (Australia)	2.5kWE Pelton	Pelton	Bronze	240V single phase	2.5	75	6.5	Synchronous	Shunt load governor	1	$21,000	Tyco Tamar manufacture a wide range of turbines, from small 100 watt DC sets for battery charging, through to turbine powered pumps, 240V single phase, 415V 3 phase and induction sets for grid connection. Specifications and prices are approximate only. To provide a firm price, they require further details of the site, which can be entered into the form on their website	Tyco Tamar 67 Main Rd, Exeter TAS 7275 ph:(03) 6394 3132 tamar@tamar.com.au www.tamar.com.au
	2.5kWE Turgo Impulse	Turgo Impulse			2.5	36	13.8				$22,500		
	2.5kWE Francis	Francis	Bronze and stainless steel		2.5	10	43.9				$49,000		
	2.5kWE Kaplan	Kaplan			2.5	5.2	85				$50,000		
	4.0kWE Pelton	Pelton	Bronze and stainless steel		4	75	10.5				$27,000		
	4.0kWE Turgo Impulse	Turgo Impulse	Bronze		4	50	14.9				$24,000		
	4.0kWE Turgo Impulse	Turgo Impulse			4	36	20.3				$27,500		
	4.0kWE Turgo Impulse	Turgo Impulse			4	28	29				$28,500		
	4.0kWE Francis	Francis	Bronze and stainless steel		4	14	58				$53,000		
	4.0kWE Kaplan	Kaplan			4	7	100				$56,000		
	10kWE Pelton	Pelton	Bronze or stainless steel	240V single phase or 415V 3 phase	10	95	18.8				$34,000		
	10kWE Turgo Impulse	Turgo Impulse	Bronze		10	65	27.3				$30,000		
	10kWE Turgo Impulse	Turgo Impulse			10	46	37.2				$38,000		
	10kWE Twin Jet Turgo Impulse	Twin Jet Turgo Impulse			10	36	49				$39,000		
	10kWE Francis	Francis	Bronze and stainless steel		10	12	142				$86,500		
	10kWE Kaplan	Kaplan			10	12	142				$85,000		
Walsh River Micro-Hydro (Australia)	LH6-180	Banki-crossflow	All welded mild steel	DC battery charging, switch selectable from 12 to 108VDC	25W to 1.6kW depending on site	0.8 to 8	6 to 18 @ 1m head, 9 to 32 @ 3m head, 14 to 52 @ 8m head	Baldor CDP series DC generator	Linear series regulation using AERL Hydromax controller	2	$3,500 to $4,900 depending on configuration	Developed by Planetary Power in 1991 to provide economical and reliable micro-hydro power for very low head sites	Planetary Power PO Box 198 Herberton 4887 ph:(07) 4096 2420 info@planetarypower.com.au www.planetarypower.com.au
	LH6-300				40W to 600W depending on site	0.8 to 3	10 to 31 @ 1m head, 14 to 43 @ 2m head, 16 to 53 @ 3m head						
Water Baby (Canada)	HYD-062	Turgo	Bronze	12, 24, 48VDC	0.5	15 to 150	0.2-2	Permanent magnet	PL20/40	1	$1,980	Regulator extra	Rainbow Power Company PO Box 240, Nimbin NSW 2480 www.rpc.com.au