

# VETT Turbine Technology

Harnessing low-head hydropower



# VETT technology harnesses the potential of low-head hydropower through innovative, low cost, fish and environmentally-friendly design and improved reliability.

Hydropower represents the largest share of renewables worldwide and is increasingly recognised as the ideal partner for variable wind and solar power. Considerable installation potential remains undeveloped however, with low-head run-of-river installations using conventional technologies often regarded as uneconomical or environmentally harmful. Decentralised, low carbon electricity potential has therefore gone unharnessed.

VerdErg Renewable Energy's VETT technology was designed to take advantage of this low-head hydroelectric power in an economical, fish and environmentally-friendly way.

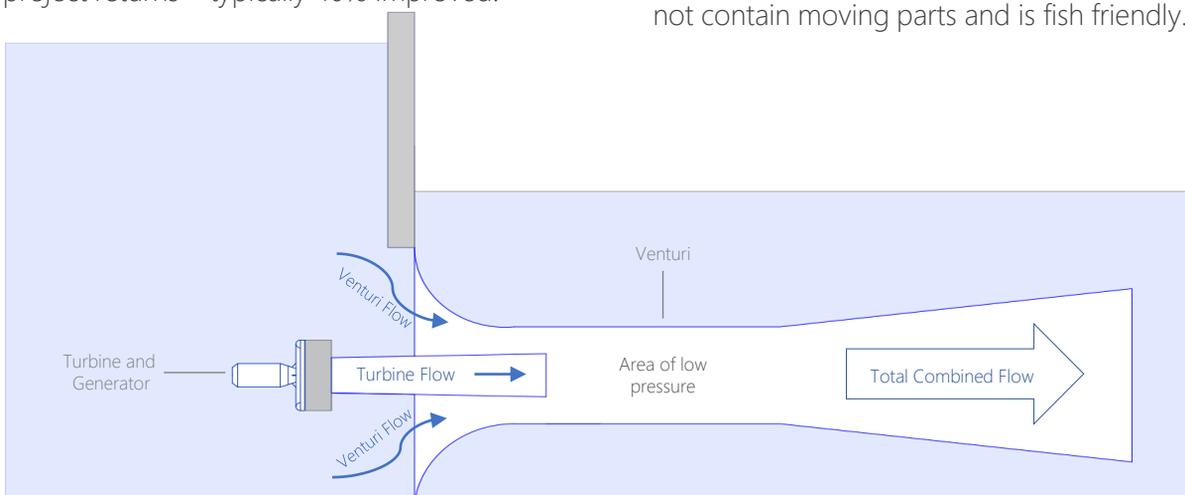
## 45% less investment costs and shorter payback periods

Designed for installation in 1-4 metres head, the patented design reduces investment risk by offering low per-kilowatt investment cost, shorter payback periods and improved project returns – typically 40% improved.

## Reducing cost by amplifying water head

VETT's low cost design centres on its innovative use of venturi principles. These principles act like a pressure amplifier and therefore increase the pressure differential across a turbine.

Instead of providing the turbine with a large volume of water at little pressure, VETT uses one part of the water in a venturi to achieve a pressure amplification, therefore providing the turbine with less water volume but at a higher pressure. The large venturi flow does not contain moving parts and is fish friendly.



The turbine discharges into a very low pressure region created by the venturi flow. The pressure differential across the turbine therefore increases as the turbine not only experiences the site head pressure but also the considerably lower venturi pressure downstream of the turbine.



The simple, robust VETT turbine is fixed blade with static guide vanes. Variable speed allows for optimum power output.

## Simple, Robust Turbine

The VETT turbine is 3-5x smaller and 4-15x faster than conventional turbines with no gearbox required, helping to reduce maintenance burden.

The simple, robust turbine has fixed blades with static guide vanes. Variable speed allows for optimum power output.

## Higher Reliability, Less Maintenance

Moving parts are kept to a minimum in the VETT's design for increased reliability, also helped by smaller and lighter mechanical and electrical equipment. Design flexibility and the possibility to use any horizontal propeller turbine in combination with VETT allows the vetted supply chain to be flexible.

## Remote, Intelligent Operation

The entire VETT hydro scheme can be operated and monitored remotely without the need for site visits. Where desired, the submerged generator can be replaced with a dry generator positioned above water.

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## Maximizing production, minimising cost

### Efficient Operation

- High turbine efficiency without gearbox
- Zero noise or visual pollution
- Remote operation and monitoring
- Reduced service complexity

### Reliable Design

- Standardised and scalable design
- Reduced components list
- Flexible supply chain
- Proven 'off-the-shelf' components



A VETT turbine-generator without draft tube during installation.

# Sustainable, environmentally-friendly hydropower with no negative impact on biodiversity, above or below the waterline.

Fish-friendly VETT technology can improve flood defences and water quality by opening up watercourses.

## Zero noise and zero visual pollution

Silent operation causes no sound impact on local eco-systems. All civil infrastructure is concealed below the waterline and no turbine house is required.

The only component positioned above the waterline is the control system in a compact electrical kiosk. This can be camouflaged into the surroundings with a location adaptable to suit the site.

This means the VETT is suitable for installation by historic or listed sites, in watercourses in areas of outstanding natural beauty or where fish safety is paramount.



A VETT turbine during installation at Eaton Socon, Cambridgeshire in the UK.

## Local Solutions, Worldwide

The VETT is also ideal for rural, off-grid electrification. The robust design minimises maintenance burden and the compact structure is easy to transport and install in remote locations. The use of 'off-the-shelf' mechanical and electrical components mean an adaptable and regionalised construction and supply chain is possible, with training for local maintenance teams.

The completely corrosion-free venturi pipe is lightweight making it easy and cost effective to transport. A flexible supply chain and smaller, lighter equipment that's easier to transport improves logistics and reduces emissions.

## Retrofitting ageing installations

Ageing hydropower installations are easily retrofitted with the VETT system. Its smaller mechanical and electrical equipment and lightweight design means less civil works modifications are required. This results in reduced build cost and schedule.

The VETT is therefore especially feasible for existing weirs and dams and for integrating into existing watercourses.

# Verified fish-friendly design approved by the Environment Agency

The UK's Environmental Agency concluded VETT to be 'Low-Risk' and independent third-party environmental testing classified the technology as 'Outstanding' and verified 'zero fish mortality'.

## Extensive Testing Campaigns

International testing at VisAdvies B.V. (NL) and by Fishtek Consulting at HR Wallingford (both UK) was carried out during the development of the VETT technology.

Multiple full scale test programmes took place covering a range of physostomic and physoclist fish. Testing included juvenile and mature fish, such as: Atlantic salmon, rainbow trout, round goby, bream, lamprey, perch and European eel. The VETT system therefore provides a safe downstream migration route.

VerdErg Renewable Energy worked together with the Environmental Agency to develop an environmental acceptance criterion for installations.

Only a small part (typically 20%) of the total flow passes through the turbine, reducing the size of required fish screens by 5-9x compared to conventional propeller turbines.

The vast majority of water (80%) flows through the venturi pipe and encounters no moving parts, making it one of the safest fish-friendly designs on the market.



A view down a VETT venturi pipe, during installation. There are no moving parts, making it one of the safest designs on the market for fish.

## Scaling from kW to MW

The principles of the VETT system and its ability to amplify pressure in low-head settings is completely scalable. The technology is designed and installed according to site requirements and can be scaled simply by adjusting the pipe dimensions to match different head and flow conditions. For very large flow conditions, multiple units can be installed in parallel.

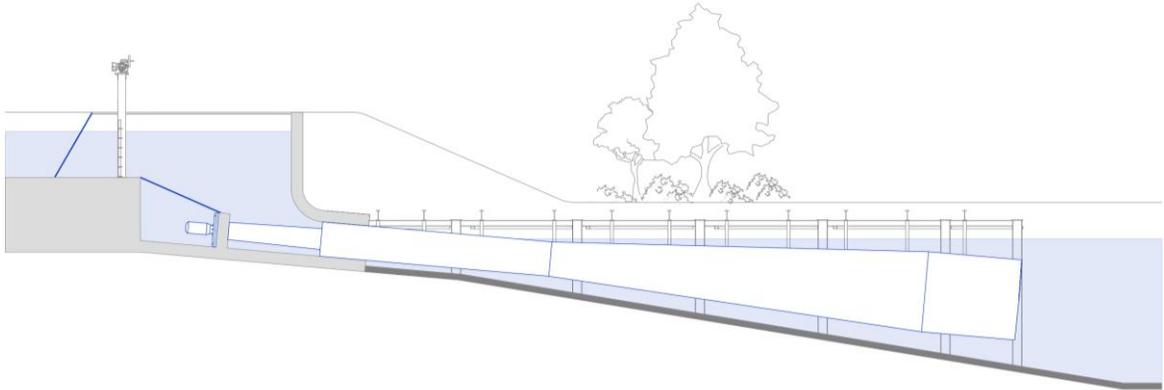


Illustration of VETT system installed in river bank. The lightweight GRP venturi pipe is not required to be installed on a foundation but can simply be hung from pilings (as installed at Eaton Socon, UK).

## Reduced Fish Screening

Fish safety is a fundamental requirement for hydropower projects. Environmental design requirements (e.g. apertures, approach velocities) as well as the hydrodynamic conditions lead to fish screens of substantial size, which can render projects uneconomical from an initial investment as well as maintenance perspective.

In a VETT system however, only 20% of the flow passes through the turbine hence the size of the fish screen is 5x smaller and under certain conditions as much as 9x smaller. The remaining 80% of the flow washes over the screen, thereby cleaning it.

Screen aperture	Screen size for 10m <sup>3</sup> /s total design flow		
	VETT		Conventional
15mm	19m <sup>2</sup>	11m <sup>2</sup>	95m <sup>2</sup>
6mm	22m <sup>2</sup>	13m <sup>2</sup>	112m <sup>2</sup>
2mm	34m <sup>2</sup>	18m <sup>2</sup>	168m <sup>2</sup>
<i>Required blockage assumption*</i>	50%	10%*	50%

\* 10% permissible where water washes over screen (self-cleaning).

## Case Study: Eaton Socon, UK



The 26kW VETT scheme, installed in 2018 at Eaton Socon in Cambridgeshire, exploits the 1.4m gross head between a marina and mill pond. The VETT is submerged within a disused underground culvert. This followed key design criteria to integrate into existing infrastructure of a Grade-II listed former mill, preserving the surroundings of the site on the river Great Ouse which is situated between two nature reserves.

The river Great Ouse is a navigable stretch of river prone to flooding. VerdErg Renewable Energy therefore coordinated the VETT scheme with the management of water levels by a Environment Agency sluice at Eynesbury Weir.

Careful eel passage design newly opened this stretch of water to migrating eels. Installation and operation was designed to protect juvenile coarse fish nursery areas in the marina and mill pond and to accommodate eel passage.

3,500 litres of water passes through the VETT installation per second, on average. The turbine is 440 mm in diameter and emits zero noise with all infrastructure submerged underwater. Generated electricity supplies a pub and restaurant in the old mill with excess exported to the National Grid.



### Key Facts

- Net Head: 1.2m
- Installed capacity: 26kW
- Energy Output: 70MWh
- Design Flow: 3.5m<sup>3</sup>/s
- Results: 35t carbon emissions saved per year with electricity for 22 homes

### VETT Technical Specifications

- |                                     |   |
|-------------------------------------|---|
| • Run-of-river                      | • Up to 10,000 l/s per unit               |
| • 1.0 - 4.0 metres head differences | • Suits urban as well as remote locations |

### VETT Customer Benefits

- |                           |                                      |
|---------------------------|--------------------------------------|
| • Proven fish-friendly    | • Low maintenance                    |
| • Low cost infrastructure | • Easy integration into watercourses |
| • Fast, compact turbine   | • Flexible, scalable design          |
| • Zero visual impact      | • Zero noise impact                  |

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