

# Boatslide Hydro Power Facility Archimedean Screw Turbine



## Who was Archimedes?

Archimedes was a Greek astronomer, mathematician and philosopher and is regarded as one of the leading scientists of Classical Antiquity. Born in Syracuse on the eastern coast of Sicily around 287 B.C. he was educated in Alexandria in Egypt before returning to Syracuse. He is credited with inventing a range of innovative machines including the design of the screw pump or hydraulic screw which now takes his name.

## What is an Archimedes Screw Pump?

An Archimedes Screw or Archimedes Screw Pump consists of a large spiral screw which turns inside a close-fitting inclined cylinder. The bottom of the screw is submerged in the water and is turned manually from the top. As the shaft turns, water is scooped up in the first thread and raised up a thread at a time and the water emerges at the top of the cylinder (see image below).

The Archimedean Screw pump has been used for hundreds of years to pump water from low lying rivers to irrigate crops and drain land and is still in use today on the Nile delta. It is also still used in sewage treatment works although the screws are now turned by motors.



## What is an Archimedes Screw Turbine?

The Archimedean Screw Turbine works on the same principle as the Archimedes screw pump but in reverse. When water enters the top of the shaft the weight of the water pushes on the screw blades causing the shaft to rotate allowing the water to fall to the lower level. The rotation of the screw can then be converted into electricity by connecting a gearbox and generator to the main shaft of the screw turbine (see photograph above).

## The Screws and Turbine House

The hydro power facility has two Archimedean Screws. Each screw is 2.3 metres in diameter and 3 metres in length. Up to 2,600 litres of water per second can pass through each screw in normal river conditions.

The screws are connected to a gearbox which in turn drives a generator which produces renewable electricity. This electricity powers lighting along the river and also feeds into the national grid. The amount of electricity produced is dependent on river levels, but based on historic river levels, the average annual production will be approximately 130,000 kWh of power.

The Turbine House contains the control equipment and has been designed to compliment the nearby Schools Boathouse. The equipment can be accessed remotely, allowing for monitoring and controlling of the plant.

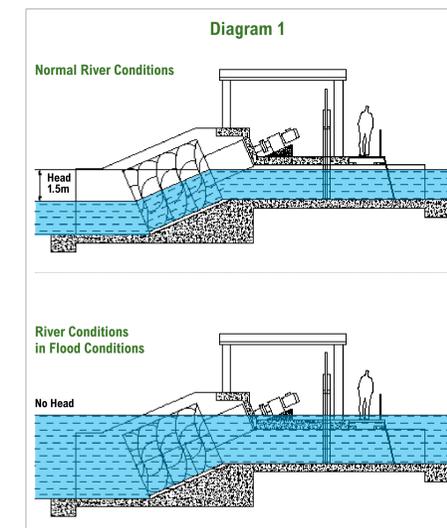
The construction of the hydro power facility has enabled the Council to restore this previously derelict site and recover the full construction costs.

## How do river levels impact on the Hydro Power facility?

The hydro power facility is automatically controlled to ensure it operates within the parameters set by the Environment Agency. This is to make sure the river levels are maintained on the upper river. The Environment Agency has set the level of 24.86 AOD (above ordinance datum) at which level or above the hydro power facility can operate. If the upper river level falls below this the hydro power plant automatically closes down.

The power that can be generated from the Archimedean Screw Turbine depends both on the flow of water and the head of water. The head of water is the difference between the levels of the upper and lower rivers. The greater the head and flow the greater the rotational speed. The Archimedes Screw Turbines were specifically chosen as they can operate efficiently with a low head of water, such as is the case at the Boatslide where the head is approximately 1.15 metres. The head can dramatically reduce when the river is in flood flow as illustrated in Diagram 1.

When the head reduces or flood conditions are experienced the Archimedean Screw Turbines will automatically close down and then restart when the head improves. The automatic control system also allows the pre programming of shutdowns to enable use of the Etienne Stott White Water Arena.



## Frequently Asked Questions

### Is the hydro power facility safe for fish and other wildlife?

Yes. The screws are recognised as 'fish friendly' because fish can move freely through the screws. The facility also incorporates an elver channel and is designed to protect other animals such as swans.

### How long will the plant work for?

Archimedean Screw Turbines are a relatively new way of producing electricity. However, similar screws are operating in the more demanding environment of sewerage farms after 40 years. Therefore the hydro power facility should produce at least 5,200,000 kWh of electricity before they may need to be replaced.

### Why Archimedean Screw in preference to other turbines?

The use of Archimedean Screw Turbines for mini hydro power facilities to generate electricity is a relatively new development. Archimedean Screw Turbines have the benefits of being able to operate at heads as low as 1 metre, are fish friendly, low maintenance and have a long design life.

### When will the screws close down?

The hydro screws will operate unless one of the following apply:

- There is an event scheduled for the Etienne Stott White Water Arena
- The river levels have dropped below 24.86 AOD
- The river is in flood or water levels reduce the available head (difference between the upper and lower river levels).
- The intake screens are being cleaned.
- The plant is undergoing routine or special maintenance.
- There has been a power surge on the local power network and the plant trips out to protect the system.

### How is the facility performing?

During 2014-15, the facility generated 154,735.35 kWh of electricity and exported 147,880.50 kWh, providing an income to the Council of £37,866.49. This gives a payback time for the facility of approximately 14 years.