



**Esk Energy (Yorkshire) Limited**

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**Annual Report: April 2019 - March 2020**

We were pleased that at the AGM, in September 2019, Rory Newman was appointed as a Director following his co-option the previous November. Rory has been a great addition to the team of Directors.

As well as running the community hydroelectric scheme, the Esk Energy team also help promote the development of community energy nationally through our membership of Community Energy England and taking part in consultations. Education is important to the Esk Energy team. Therefore, we were particularly pleased to be mentioned in an article in the February 2020 edition of *Physics Review* published by Hodder Education and to be chosen by eFixx, (an education site for the electrical trade) to be the subject of a video for electricians to learn about hydro-electric power. This year, we worked with a BEng student from Durham University and were also visited by researchers from the University of Guelph in Canada and students from the University of Hull.

During the year we paid, as planned, approximately £17,700 in capital repayments and interest on our outstanding loan to North York Moors National Park. The final payment is currently planned to be paid in March 2025.

We had a very dry spell in the first half of this financial year followed by a very wet Autumn; overall we had our second best year of generation. Between April 2019 and March 2020, we generated 127,180 kWh of electricity. The Directors considered the financial health of Esk Energy and decided that they were able to make a payment of 2% on Ordinary members' share capital for 2019-20.

**Physics Review**

# Water power

For over 2000 years people have used water-driven machinery. The oldest record of a water mill dates from about 3500ce, in the Persian Empire. Water mills were widely used in medieval times. For example, the Spanish city of Cordoba had a water mill before the Islamic conquest in 711 ad, and a later structure (1) was in use from the twelfth to the fifteenth centuries.

Water was first used to drive electrical generators in the late nineteenth century, and in 1876 Cragside in Northumberland became the first house to be lit by hydroelectricity (2).

In a hydroelectric power station where water flows downhill from a reservoir (3), the power output depends on the head of water and the flow rate through the turbine that drives the generator (4).

In 2018 the International Energy Agency reported that hydroelectric power produced a total global output of 423 TWh (1 TWh = 10<sup>12</sup> kWh = 3.6 × 10<sup>15</sup> J). This was 16% of the world's total electricity generation and the largest contribution from renewable sources (5).

Much of the world's hydroelectricity comes from large-scale schemes. The largest is the Three Gorges Dam project in China (6), which has 32 turbines that can each generate 700 MW from a water head of 80–113 m and a flow rate of 600–9000 m<sup>3</sup> s<sup>-1</sup> plus two 50 MW turbines.

Hydroelectric power does not always involve engineering on a vast scale. In the UK there are numerous community hydroelectric schemes (7), with powers of typically 50 kW. They supply electricity to local homes and businesses and sell any excess to the National Grid. You can see an animation and the data from one such scheme (8) here: [www.whitbyeskenegy.org.uk/generating](http://www.whitbyeskenegy.org.uk/generating). To find details of similar projects near you, visit: <https://eshk.communityenergyengland.org/projects>.

**1 Cordoba's medieval water wheel**

**2 The original switchboard from Cragside's hydroelectric system**

**3 A hydroelectric power station**

**4 Hydroelectric power**

When water with mass  $m$  flows down through a height  $h$  there is a loss of gravitational potential energy  $E_p$ :

$$E_p = mgh \quad (4.1)$$

where  $g$  is the gravitational field ( $g = 9.81 \text{ N kg}^{-1}$ ).

If this mass  $m$  flows through a turbine in time  $t$ , the power output  $P$  from the generator is:

$$P = \frac{mgh}{t} \quad (4.2)$$

The efficiency of the process,  $\eta$ , is often expressed as a percentage. It is always less than 100% because not all the energy can be transferred to the turbine, and there is always some energy dissipation in the machinery. Large hydro power stations can have efficiencies of over 90%. Equation 4.2 is often written as:

$$P = \eta \rho g Q h \quad (4.3)$$

where  $\rho$  is the density of water and  $Q = \eta h$  is the volume flow rate.

**5 Global electricity generation in 2018**

Source	Percentage
coal	37%
gas	23%
nuclear	10%
hydro	7%
wind	6%
biomass and waste	5%
oil	4%
total	26 700 TWh

**6 The Three Gorges hydroelectric dam in China**

**7 The Bainbridge community hydroelectric turbine in Winstleydale, Yorkshire**

**8 Data display animation from Whitby Esk Energy, a community hydroelectric project near Whitby, Yorkshire**

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