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GALLOWAY HYDROS TECHNICAL FACTSHEET

SCOTTISHPOWER
Energy Wholesale

OVERVIEW

Energy Wholesale's hydro-electric scheme at Galloway in the south of Scotland, is one of the company's oldest generating sites. Although its output is relatively small, the scheme, with its six stations, has proven to be a reliable, flexible generator of clean, renewable electricity and a valuable asset in the company's portfolio.

With its 75th anniversary in 2010, the scheme is receiving considerable ongoing investment to maximise its efficiency and generation output for many years to come.

INTRODUCTION TO GALLOWAY HYDRO-ELECTRIC SCHEME

The Galloway Hydros, commissioned in the mid 1930s, was the first large-scale integrated hydro-electric complex to be built in Britain for the purpose of public electricity supply.

The scheme covers a large area in Galloway and South Ayrshire and consists of six power stations with an installed capacity of 109 MW, eight dams plus a network of tunnels, aqueducts and pipelines.

From north to south these stations are Drumjohn, Kendoon, Carsfad, Earlstoun, Glenlee and Tongland.

Glenlee Power Station, near St John's Town of Dalry, is the nerve centre of the scheme and can operate other stations via remote controls.

Loch Doon, at the head of the scheme, is the principal storage reservoir. It is a natural loch but its level has been raised by the construction of a dam.

A tunnel diverts water from the Water of Deugh and the Bow Burn into Loch Doon for storage.

When additional water is needed for the power stations downstream, water is released through Drumjohn Power Station from where it flows to Kendoon reservoir, which supplies Kendoon Power Station, 45 metres below.

■ *The 33 MW station at Tongland*

Further downstream, dams built across gorges provide water for the Carsfad and Earlstoun stations.

Glenlee Power Station is supplied by Clatteringshaws Loch, a man-made reservoir created by building a dam across the Blackwater of Dee to flood adjacent marshland. Water from Clatteringshaws, 125 metres above Glenlee, is transported to the power station via a 6km tunnel and a pipeline.

Water from the first five power stations gathers in Loch Ken, a natural loch near Castle Douglas, that also acts as a storage reservoir for Tongland Power Station.

The release of water out of Loch Ken is controlled by the Glenlochar Barrage, which has six lifting sluice gates.

After Tongland Power Station has extracted its energy to make electricity, water is released into the River Dee, where it flows to the estuary and into the Solway Firth.

■ *Carsfad, a 12 MW power station, and its 503m dam wall – the longest in the scheme*

Name of station	Drumjohn	Kendoon	Carsfad	Earlstoun	Glenlee	Tongland
Catchment area (km²)	394	394	442	502	122	1023
Average net head (m)	13	46	20	20	116	32
Consumption at full load (m³/sec)	15.6	55	73	71	25.5	127
Station capacity (MW)	1 x 2.25	2 x 12	2 x 6	2 x 7	2 x 12	3 x 11
Date of commissioning	1985	1936	1936	1936	1935	1935
Turbine speed (rev/min)	300	250	214.3	214.3	428.6	214.3
Load factor (%)	40	24	22	22	25	29

HARNESSING THE POWER OF NATURE

Hydro stations can generate electricity for the grid very quickly. Glenlee Power Station can, for example, generate 24 MW within five minutes.

However, the stations' output and running times also depend on the availability of water.

In summer, when rainfall is less, the Galloway stations usually operate for short periods to meet daily peaks in demand.

In winter, when water levels in reservoirs are generally high as a result of increased rainfall, the stations can run for longer.

To support this operating pattern, reservoirs at Kendoon, Carsfad, Earlstoun and Tongland are generally used for daily storage – drawn down when the stations are running and replenished when they are not, depending on rainfall.

Loch Ken is used for medium-term storage and acts as a buffer for Tongland Power Station, helping to lessen the impact of flooding.

Clatteringshaws Reservoir and Loch Doon are used for seasonal storage – they are the largest in the scheme and have considerable capacity to store water – and are drawn down in spring and summer then replenished in winter.

CONTACT US

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HOW OUR HYDRO STATIONS WORK

Each of the six power stations that form the Galloway hydro-electric scheme work in similar ways to convert the force of flowing water into electricity.

① The amount of electrical power that can be generated is related to the water flow rate and the vertical distance – the head – through which the water has fallen.

② Turbines extract the kinetic energy of flowing water and convert it to mechanical energy, through the turbines rotating at high speed.

③ The turbines drive a generator that converts the mechanical energy into electrical energy.

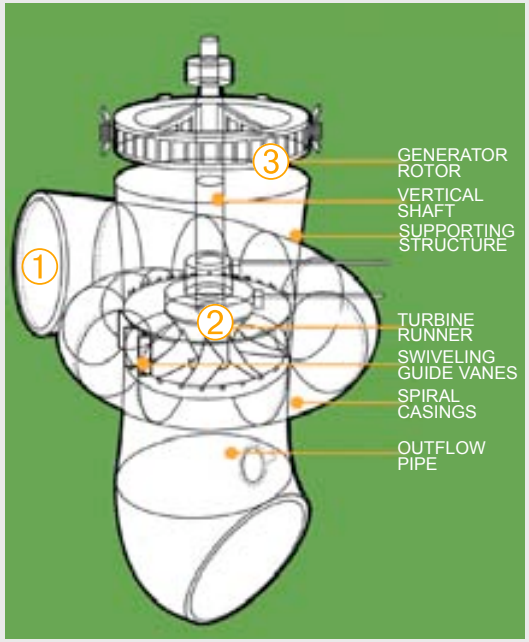
With the exception of Drumjohn, which has a 2.2 MW induction machine, the generators at the Galloway stations are of conventional rotating field design, generating an 11,200 volt-ampere, three-phase supply of electricity at a frequency of 50 Hertz.

The 11 kilovolt (kV) electricity output from the turbogenerators is stepped up to grid voltage of 132kV in a substation, or transfomer compound, beside each power station.

The generators at each station are scheduled and controlled remotely from Glenlee, according to customer demand and available water.

The flow of water to the turbines can be shut off by closing intake gates at the top and (in four stations) valves at the bottom of the pipelines.

At some stations, surge towers or chambers protect the pipelines and turbines by absorbing sudden variations in water pressure.



A cut-away diagram of a turbogenerator

A turbogenerator at Glenlee Power Station

GALLOWAY'S DAMS

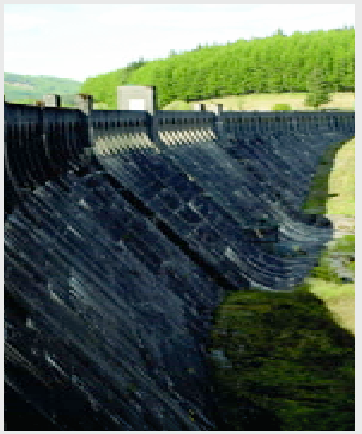
Building the scheme's dams was one of the major civil engineering challenges during the construction of the Hydros.

Around 1,500 men were employed in the project at its peak.

There are two types of dam within the scheme. Gravity dams rely on their own weight for stability while arch and gravity dams incorporate a sharp curve to resist the thrust of the water.

Spillways and, where necessary, floodgates, carry away excess water.

Many of the dam structures incorporate fish passes to encourage movements of Salmon – see our **Fisheries Management** factsheet for further information.



Clatteringshaws (left) a gravity dam, and Tongland Dam (arch and gravity)

Name of dam	Doon	Deugh	Ken	Blackwater Burn	Carsfad	Earlstoun	Clattering-shaws	Glenlochar Barrage	Tongland
Type	Gravity	Arch and Gravity	Arch and Gravity	Arch and Gravity	Arch and Gravity	Arch and Gravity	Gravity	Six lifting gates	Arch and Gravity
Length (m)	299	238	253	186	503	213	457	103	298
Height above river bed (m)	13	26	25	15	21	20	24	11	22

Tunnels and aqueducts	Doon tunnel	Deugh tunnel	Kendoon aqueduct	Glenlee tunnel	Glenlee pipeline	Tongland aqueduct
Length (m)	1942	2138	762	5791	435	1017
Average diameter (m)	2.4	1.95-2.45	4	3.35	2.6	6.1

Construction of the 5.79 kilometre concrete-lined Glenlee tunnel, which supplies water to Glenlee Power Station, took 500 men two years to complete, at an average of 41m per week.

Name of reservoir	Loch Doon	Clattering-shaws	Loch Ken	Kendoon Dam	Carsfad Dam	Earlstoun Dam	Tongland Dam
Spillway level above ordnance datum (m)	215	178	45.1	155	103	74	36.6
Area at spillway level (km²)	8.4	3.7	8.6	0.56	0.37	0.52	0.18
Drawdown (m)	12	12	1.2	2.4	0.6	0.6	3
Storage (millions of cubic metres)	82.5	36	9	11.4	0	0	8.8
Storage (millions of kilowatt hours)	23	12	0.65	0.23*	0.02†	0.01	0.065

* Comprises energy generated at Kendoon, Carsfad and Earlstoun † Comprises energy generated at Carsfad and Earlstoun