Community Hydro Schemes on the Isle of Raasay

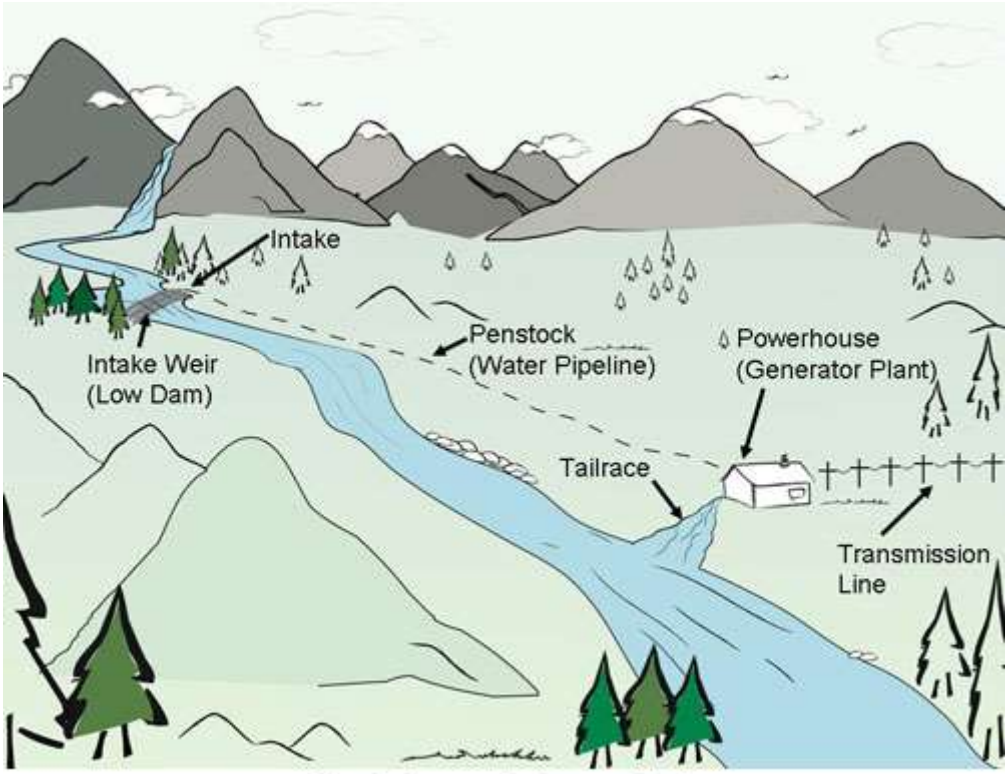
Community presentation/consultation – 25th February, 2015

This evening I'd like to explain a bit about micro-hydros: how they work, what they look like, what we need to do to get them up and running and ultimately how they generate money for the community here on Raasay.

In January of this year Manitoba Energy were appointed by RDT to design a run-of-river micro-hydro scheme on the Inverarish Burn and acquire the relevant licences. We are obviously very grateful for the opportunity to do this work on our doorstep, essentially working for the community. Clearly we hope that the scheme is something we can all be proud of and provide a source of income for the community for years to come.

Why is renewable energy a vaiable option at the moment? The government has been incentivising micro-renewable energy generation through the Feed-in-tariff programme since 2010 and many communities have capitalised on this. We'll come onto the necessary licences and consents for the Feed-in tariff later.

Obviously before you do any of that you need a good site to capitalise on the money available and the Inverarish Burn and the surrounding area is one such site. In short it is suited to run-of-river micro hydro.



Typical run-of-river project

So, what does a 'run-of-river micro hydro scheme' entail? The basic principles of hydro electrical generation haven't changed since the first hydro-electric scheme was built some 130 years ago. In the simplest terms, the gravitational force of flowing water spins a wheel and generator which in turn produces electrical energy. Since then, advances in technology have allowed for increased automation and efficiency but the fundamentals are still the same.

Unlike schemes that dam large areas to store water in man-made lochs, 'run-of-river' schemes only use water as and when it is available in the watercourse. As such the schemes do not provide constant amount of electrical energy but rather fluctuate with the flow available.

They have a much smaller footprint and impact on the landscape and environment, as you will see. The 'micro' in micro hydro refers to schemes

under 100kW, which is the maximum output any scheme in this area will have. As a guide, 100kW is roughly enough to power ten homes. Depends on the home but that's a rough guide.

There are four main parts to a run-of-river scheme such as the one proposed here. They're called the intake, the penstock, the powerhouse and the grid connection. This drawing, which I shamelessly stole from the internet, shows them in relation to each other.

There are many variable factors in any hydro scheme but there are two overriding aspects which determine electrical output: the volume of water available and the 'head'. 'Head' refers to the difference in height between the point the water is abstracted from the burn (the intake) and the point the water hits the turbine wheel (powerhouse). So, we need height and we need water. Both are in plentiful supply on the west coast.

Things are never quite as simple as they are in this diagram however. For example, a grid connection or use for the electricity produced may not be close by. So to cut expensive electrical cabling costs, we try to move the powerhouse closer to the grid. However, environmental planners stop us because we need to return all the water used to the burn before a certain point. Each hydro is different because the lay of the land, the services around it and the potential uses of the energy differ.

LAYOUT MAP

This is a map of the scheme that was mooted in the feasibility report last year. It is located entirely on land currently owned by Forestry Commission Scotland – land earmarked for community ownership.

Officially we are exploring other options with SEPA. We have a duty to consider alternatives. Indeed, in terms of maximising annual output, moving the powerhouse closer to the village is the best option. One option is bring the powerhouse to the pit, currently used for fire wood processing. As you might expect, there are range of pros and cons to each option. They include factors such as land ownership, energy output, financial return on investment, material costs, planning permission, environmental licencing,

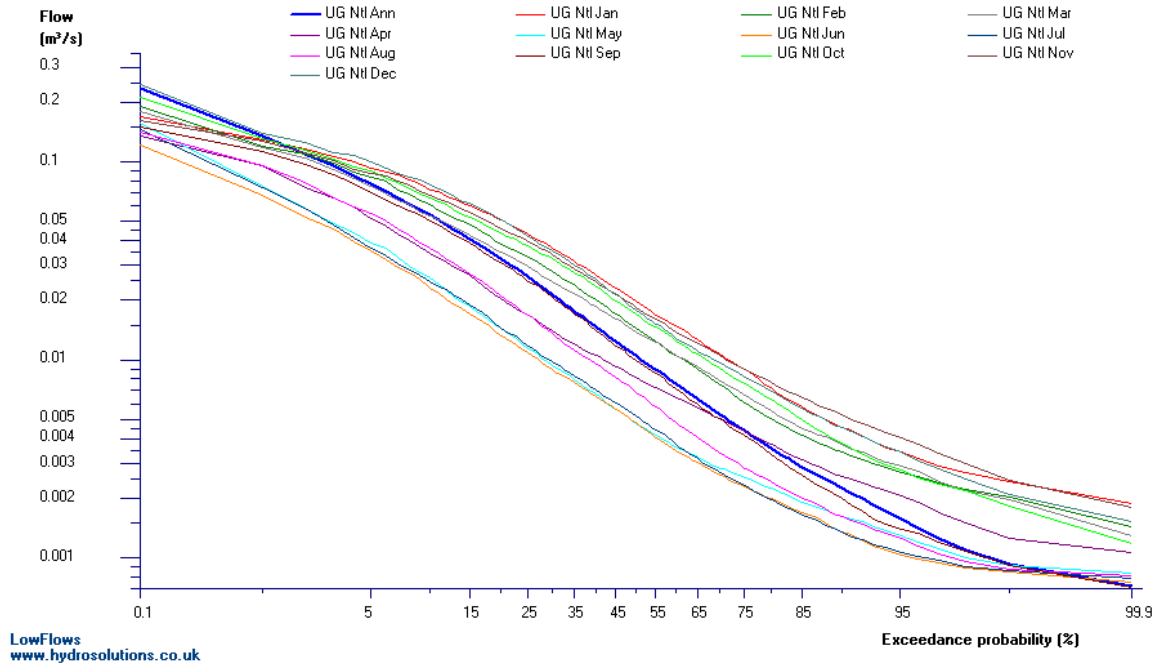
and so on. At the moment it is this layout that is most likely to be granted approval for construction by the necessary authorities.

Working through the main structures from the top downwards... water flows down the burn and meets the intake. Here is a picture of an intake we built last summer. It is a similar size to the one likely to be proposed on the Inverarish Burn. You can see that it creates a small dam, about 4 metres in length, and directs a proportion of the water over a metal screen.

The screen acts as a filter, allowing most of the water to drop through small holes whilst letting grass and sediment wash over and downstream.

This is a good time to explain a bit about an aspect of SEPA regulation for hydro schemes. On the left you'll notice a metal notch allowing water to continue down the burn unimpeded. This is called a compensation notch and it ensures that the burn continues to experience a constant flow of water. The exact amount of water is determined by SEPA and is a legal license requirement. Generally speaking, the compensation flow is similar to flow in dry periods. This means that when the natural flow in the burn drops to a certain point, the scheme will stop producing energy and consequently stop abstracting water.

In addition to this, the scheme must allow rates of flow to continue downstream that are proportional to the variation in natural flow. Put simply, this means that the Inverarish Burn will continue to experience all but the full rate of flood waters that have shaped it to this day. At present the schemes we are discussing with SEPA are well within their boundaries for water abstraction.



How do we know how much water will be in the Inverarish Burn? The truthful answer is that we don't know for sure. Following SEPA's instruction

we use well established and trusted hydrology software to estimate flows from the given catchment (almost 3km2 in the case of this scheme). Our figures are then double checked by SEPA and so far have been slightly conservative, which is most likely a good thing.

This is a graph of annual rainfall split into each month. Our compensation flow will probably be set here, at Q90. This value is known as flow exceedence or percentile flows. So for example, a Q90 flow of 20 l/sec is the flow that is exceeded 90% of the time i.e. over the course of a year you would expect to have at least this flow on 328.5 days. As a rough guide then, the scheme will not operate for roughly 5 weeks each year and the flow in the burn for this period will be unaltered.

That's enough graphs for an evening. Of course, this regulation is primarily to protect the riparian ecosystem in what's known as the affected stretch (the stretch of the burn than will be depleted when the scheme is operational). However, the effect on recreation activities is something that authorities wish to consider. I've spoken to some people who enjoy a paddle in and around waterfalls on the burn. They've expressed concerns that they'll be paddling in amongst dry rocks. I hope their minds have has been put at rest given the aforementioned regulations.

This is the site of the Inverarish Burn intake. Some of you may have been up there, 20 metres or so past the stile on the path to Duncaan. It's quite secluded. The pipeline exits the intake on the bottom left of the picture.

I'm sure you all know what a pipeline looks like but here's a picture anyway. The penstock is just that, a buried pipeline, made from black HDPE plastic and most likely 400mm in width on this scheme. It is buried 1 metre deep where possible. Planning authorities will be looking to make sure the penstock does not go through any sensitive areas and that the construction techniques used are appropriate.

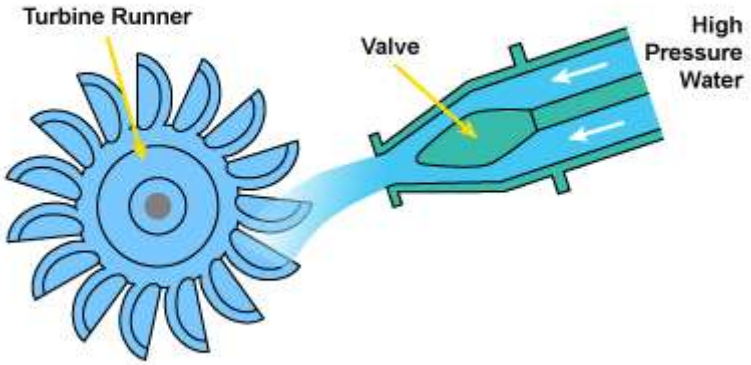
The top section of penstock follows the existing Forestry track until the military bridge just north of the car park. Historic Scotland have asked us to move the penstock approximately 50 metres west at this point to avoid the Scheduled Monument area. Consequently a pipe bridge similar to the one in this photo is proposed just west of what i believe to be the slag heap from the iron ore mine.

As the penstock winds its way down, the water pressure inside it builds up. If the powerhouse is to be sited in the forest then the pressure at the bottom of the penstock will be in the region of 10 bar as the head is around 100 metres. That's roughly 5 times the pressure in your car tyres.

The penstock enters the powerhouse. The powerhouse is a shed with a few structural modifications to accommodate the turbine, generator and ancillary equipment. This is an example of one we built last summer on Skye. It's roughly 5x5 metres and 3.5 metres to the apex of the roof. You can see the pipeline enter the building on the right hand side.

This is the turbine and generator. The turbine in this system has a twin jet configuration. The generator sits on top of the turbine casing. To the right

and left of the generator you can see the spear valve assemblies. The spear valves control the flow of water through the two jets depending on the flow of water in the burn.



Here you can see how the pressurised water drives the turbine. The turbine is connected to a generator by a shaft which in turn creates electrical energy. This energy can be connected to a local dwelling, community hall, shop or hot tub. It is also connected to the grid via arrangement with SSE for sale to energy companies.

Once the energy in the water has gone into spinning the turbine it falls into a sump and is transported from the powerhouse to an outfall via a buried tailrace. You can just see the water being returned to the burn on the right hand side here.

This is an outfall. The water is preferably returned onto bedrock to avoid excessive erosion to the river bed.

Once the scheme has been commissioned and any teething problems sorted out (usually tweaking the ancillary control equipment) hydro schemes such as these are relatively straightforward in terms of maintenance.

The intake screen shown here is designed to be self-cleaning. Every now and then it may necessary to scrub algae off to ensure optimal operation. This can be done safely by someone attached to a harness with a scrubbing brush.

The penstock will require 'pigging' roughly every two years. Pigging involves sending a large sponge down the penstock to remove any gunk from the inside walls. No chemicals are required and the whole process should take no more than half a day.

Similarly, bearing replacement is required every two (?) years. All these maintenance procedures are carried out in summer months when the plant is not operating due to low flow.

This is the device that tells you how much energy you're producing. Monitoring of the scheme can be done remotely using mobile telecommunications allowing any faults to be quickly identified.

VIDEO

Obviously the turbine and generator produce noise - in the region of 75dB if you're 1 metre away. This is similar to standing next to a washing machine on a vigorous spin setting. In a normal corrugated steel powerhouse the machinery's noise fades away once you are 30 metres or so away from the building. If the powerhouse is located in the forest without insulation then it will probably be faintly audible from the road on a calm day.

Visual impact – The intake, pipe bridges and powerhouse are the only visible aspects to the scheme. Whilst these are mainly recessed in amongst trees structures it is hoped that their practical application in the hydro will be something the community can be proud of and be a focal point rather than something hidden away.

With regards the powerhouse, as long as it can accommodate the necessary equipment the exterior can be pretty much anything you like, providing funds are available and planning permission is granted. Stone clad, larch clad, green box profile…

Recreation – I've mentioned the bathing in the waterfall. I can't think of any other recreational activities that will be affected by the operation of the scheme. The construction of the scheme will last for approximately three months.

LICENSING GRAPHIC

That's a run through of what a typical scheme looks like/ sounds like and some of the issue arising from such a scheme. We'll come to costs in a second but aside from funding, what do we need to do to get to the stage where a scheme is generating not only renewable energy but money for the community?

There are three main sources of income for a hydro scheme. Firstly, energy produced by the scheme can be used locally, saving on energy bills. Secondly, renewable energy can be sold to the grid. Lastly, and this is the most profitable part, a scheme receives payments related to the amount of energy produced through the government's The Feel-in-tariff scheme.

Every year the tariff reduces incrementally. Anyone with the relevant licences and consents can 'pre-accredit' with Ofgem for a given tariff - that is, lock into that particular year's tariff. Providing they commission the scheme within two years of 'pre-accreditation' their scheme will be paid a certain amount per kWh produced. It is therefore important to have the licences granted sooner rather than later.

The licences and consents required are a grid connection offer (in this case from SSE), planning permission (from Highland Council) and a CAR licence (from SEPA).

SNH, Historic Scotland

There are a range of conditions, restrictions, practicalities, regulations and rules that govern what can and cannot be done. I will not go through them all individually however, here are some of the considerations.

Grid: At the moment there are certain restrictions on how much energy you can feed into the grid. John will talk about this in detail in a bit.

SEPA: Any hydro scheme will have a negative impact on the watercourse from which it abstracts its water. SEPA are charged with balancing the government's pursuit renewable energy targets with environmental risk. As such they consider impacts of the depleted reach on protected species –

otters, water vole, eagles, etc. SEPA are currently considering the effect of the scheme on fish habitat on the burn.

Highland Council: The local planning have indicated they would be looking to approve a scheme with a powerhouse in the forest. They will only consider a hydro application if SEPA have given the go-ahead.

Historic Scotland

The Iron Ore Mine buildings and associated remains are slap bang in the middle of the Inverarish Burn pipeline and as I mentioned we will move the pipeline slightly to satisfy HS. The Mine burn intake is situated close to the mine entrance and any pipeline will have to traverse a scheduled monument area. Therefore we will have to put our case to them and wait and see.

SNH

SNH act as consultants to SEPA and Highland Council. It is likely that they will respond favourably to the bryophyte survey done last year which found a variety of mosses, lichens and liverworts but none that were especially scarce in this part of the world.

Grid – John will talk a bit about the grid and how that affects the options open to us.