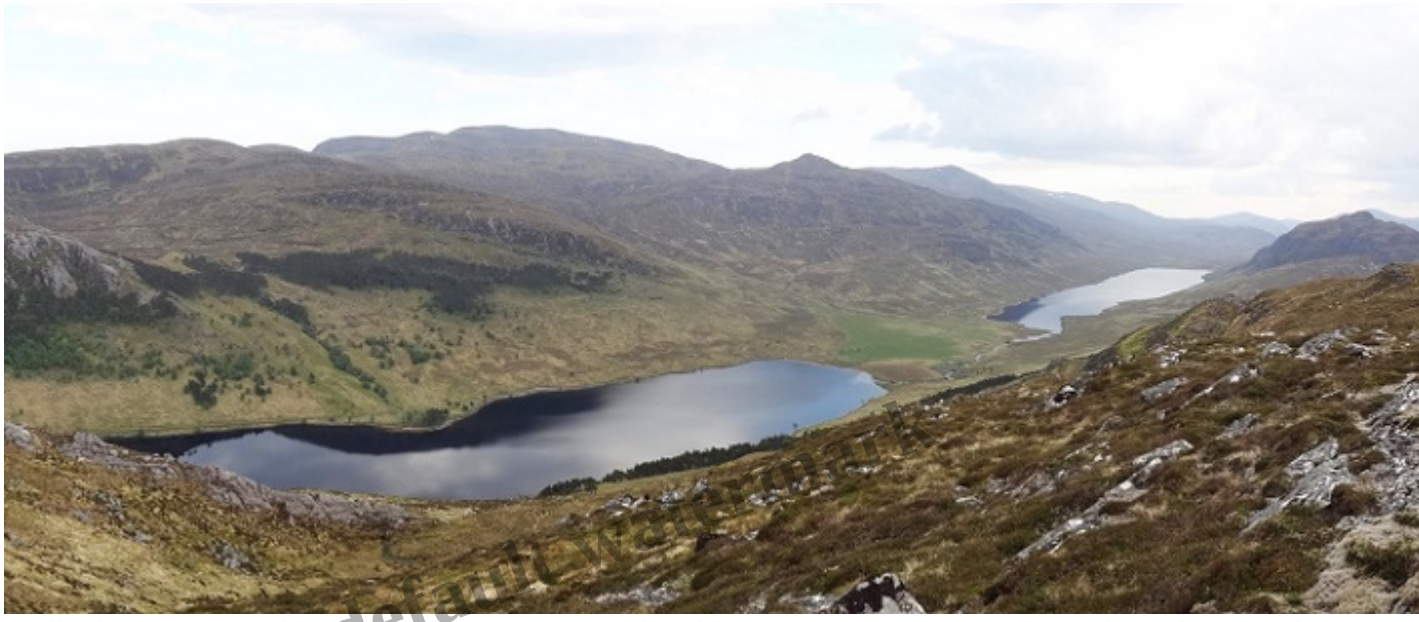
How green is pumped storage hydro? The case against the proposed scheme at Lochan na h-Earba.

Description



Mullach Coire an Iubhair awaits – from Binnein Shios across Lochan na h-Earba, Binnein Shuas on the right, Creag Pitridh is the pimple. The pony path heads up from the green camping grounds of Am Magh, which will entirely disappear. Photo from David Jarman's previous post.

David's Jarman's post (see here) on the destructive impacts of the proposed Lochan na h-Earba pumped storage hydro (PSH) scheme and the fate awaiting Scotland's landscape, natural environment and cultural heritage appears to have struck a cord. Many people who strongly support the need to reduce carbon emissions and recognise that we need to store electricity have accepted on trust that PSH is the way to do it without having the time to understand its role or think through the implications. What David did was to describe passionately how the Earba hydro would destroy what is so valued by many people and in doing so has helped bring misgivings into the open. The purpose of this post is to build on that by critically examining the rationale for Earba and PSH schemes more generally.

The place of pumped storage hydro in storing electricity

If we are to reduce the carbon emissions which are heating the world and driving climate change we need to decarbonise the production of power. That means moving from burning fossil fuels to producing electricity through "renewables" and, because of the volatile nature of most sources of renewable energy, finding ways to store the electricity they produce in the good times.

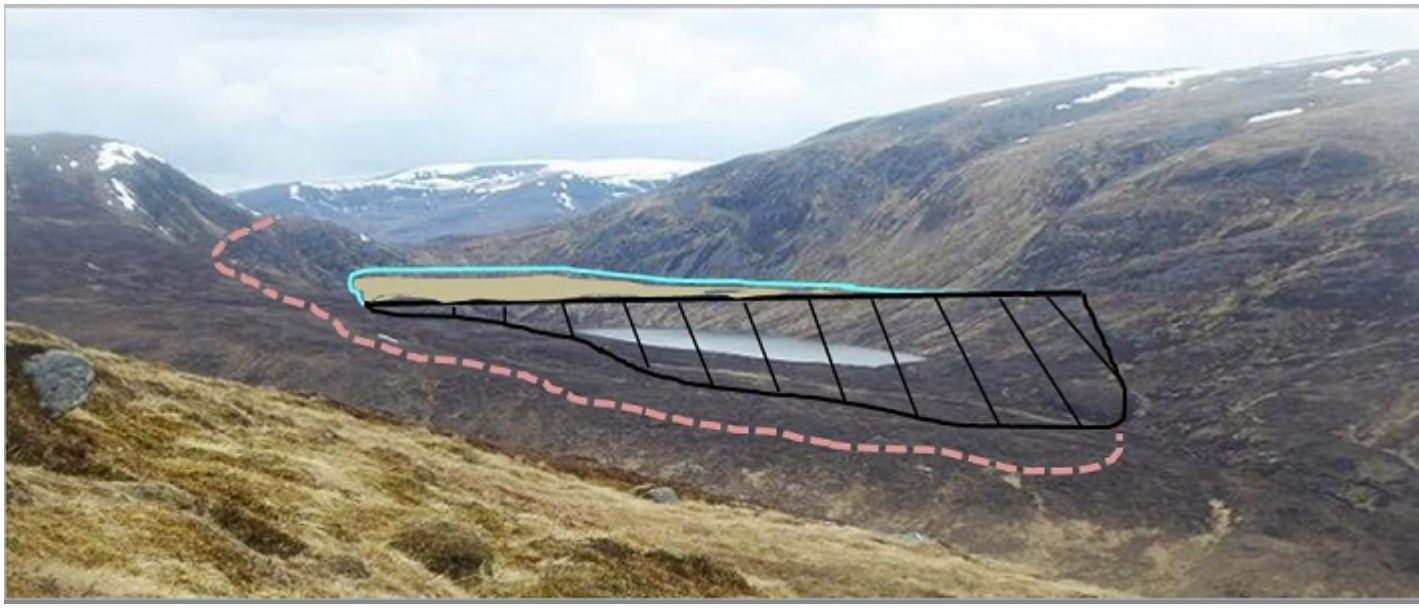
Earlier this year the Royal Society – not government! – produced an excellent report on Large-scale

electricity storage (see here). Its a forward looking report, which looked at whether it was possible to eliminate use of fossil fuels for energy completely and concluded that *"In 2050 Great Britain's demand for electricity could be met by wind and solar energy supported by large-scale storage.*" PSH is only mentioned four times in the 80 page report. That may surprise many people but the reason for this is that PSH is almost irrelevant to the big picture. The Royal Society report explains why:

"The demand for electricity in GB in 2050 is assumed to be 570 TWh/year in most of this report. In principle it could all be met by wind and solar supply supported by hydrogen, and some small-scale storage that can respond rapidly, which is needed to ensure the stability of the transmission grid." [TWh = a terawatt hour which = 1000 Gigawatt hours (GWh) which = 1000 Megawatt hours (MWh)].

However, to achieve this the report states that storage capacity of around 60 to 100 TWh is required or *"over 1000 times that currently provided by pumped hydro in the UK, and far more than could conceivably be provided by conventional batteries*". The total capacity of the four existing PSH schemes in the UK, which include Cruachan in Scotland, is 32GWh. The total potential capacity of these and the 16 other schemes the British Hydropower Association (see here) describes as "being in the pipeline" – some are only at the conceptaul stage – is 135GWh of storage. Even if all that iwere to be delivered it will be a tiny percentage of the total storage needed.

Earba would be the largest PSH scheme to date in the UK with a storage capacity of 40GWh and a generating capacity of 1.8GW. According to the description of the scheme on the Scottish Government's Energy Consents Unit (ECU) website (see here) it could, at full capacity, generate electricity for up to 22 hours. Elsewhere the designer, Gilkes Energy, claims (see here) the project will power "over 1,400,000 UK households per year". There is no explanation of what this means but it cannot be true.



The catchment above Loch Leamhain is very small which means relatively little water drains into it. Graphic credit David Jarman

The Earba PSH scheme would effectively be a closed system as only small quantities of water fall or flow into the constricted corrie where and the upper reservoir would be constructed. Power generation

is therefore entirely dependant on water being pumped up from the lower reservoir at Lochan na h-Earba to the upper reservoir before it can be released to generate electricity again. A power source that runs out after 22 hours and then requires excess wind generated electricity and time – a further constraint – to pump water back up the hill clearly cannot power anything for a year.

It is not just Gilkes that is making these extravagant claims. In July, for example, the Intelligent Land Investments Group (see here) claimed its 1.5GW scheme for Loch Awe would generate *"enough electricity to power 4.5M homes"* three times the number of the larger Earba scheme! It is time environmental organisations and the public started questioning all these figures and demanding developers explain what they mean.

Even if the upper reservoir at Earba was full at the start of one of those cold windless periods which can last a couple of weeks, using Gilkes' figures producing electricity for 1,400,000 households for 22 hours would only be of limited help. To put the "1,400,000" claim in further context at present households in the UK only consume about a third of all electricity generated. Even if true, it is a fraction of what is needed. That is why the Royal Society report puts such emphasis on hydrogen storage – without it the whole of the UK faces shutdown during any windless period that lasts more than 24 hours.

The place of PSH in short and medium term energy storage

While PSH is often described as Long Duration Energy Storage (LDES) (see here) the term is misleading. The potential importance of PSH is in providing short and medium term energy storage (i,e up to one day).

As Gilkes Energy describes it, the Earba and other such schemes (see here) could be used to provide *"fast-reaction power increases or decreases*" such as *"when weather patterns change, in emergencies such as when a nuclear power station trips, or when a sporting event results in big changes in demand, such as when a world cup football match goes into half-time.*" Like batteries, as long as there is water in the reservoir, PSH can be switched on almost instantly (30 seconds is the time mentioned for other schemes). It could thus replace the role that gas turbines currently play in stabilising the grid. And then, when demand for electricity drops, like at night, it can almost instantly use the excess to pump the water back up the hill – just like a battery recharging.

This points to the most likely medium term storage function to be provided by PSH: using excess electricity generated by wind at night to pump water back up the hill and then using this in the day to make up any shortfall in wind generated electricity compared to demand.

In its justification for the Earba scheme Gilkes claims that it could also be used *"To balance longer consecutive periods of low wind or high wind (which can last many hours, or even days)"*. While the first part of the claim is correct, the second part is false. This is both because it could only generate electricity for 22 hours but also because in long periods of "excess wind" once the upper reservoir is full it will sit idle. (I have been unable to find any estimates about how long the pumps at Earba would take to refill the reservoir)

Until recently PSH was the only real option for providing these short and medium terms energy storage functions, vital for stabilising the grid and making use of excess electricity. That, however, has now

changed as a result of developments in Compressed Air and Liquid Air technology. Last week Scottish Government announced (see here) that it was backing a 3.5GW liquied air development at Hunterston by Highview Power, the largest in the world to date. The technology has taken 15 years to develop – assisted by government grants – but is now proven to work. Basically it provides all the same functions as PSH (see here and here) and we therefore now have a viable alternative to schemes like Earba.

The financial cost implications of Earba

While the costs of wind and solar electricity generation (i.e wind turbines and photo voltaic panels) have been steadily dropping and are now lower than for fossil fuels, that only represents part of the cost of delivering renewable electricity in the UK. Our climate means wind needs to play a far greater role than sun in generating renewable electricity but since the UK's windiest places are generally remote, the grid needs to be rebuilt and enlarged to transmit power from "peripheral" rural locations to urban centres, the opposite of what it was originally designed to do. On top of this there is the cost of energy storage to cover the gaps that result from the intermittent generation of renewables.

PSH is expensive and time-consuming to construct. This helps to explain why there was a fifty year gap between the Cruachan PSH scheme, where construction started in 1959 and was completed in 1965, and SSE's 1.5GW PSH scheme at Coire Glas above Loch Lochy, approved in 2020 by Scottish Ministers. The most recent estimated costs of Coire Glas, where construction was awaiting financial guarantees about the price of electricity from the UK Government, is £1.5bn and the scheme will not be operational until 2031 (see here). These costs are created not just by the size of the dams and associated infrastructure but also by the challenges of delivering large-scale construction projects in remote places and often harsh environments.

Since the current assumption of government is that the vast majority of the costs for all types of energy storage will be privately financed, those the costs and the associated profits for investors will be need to be paid for by consumers.. This means that while the costs of erecting windfarms or PV panels may continue to fall, the actual cost of the renewable energy they produce will continue to rise. How much, however, depends in part on what technology is chosen to provide the energy storage.

In March 2023 the UK Climate Change Committee published a report called "Delivering a reliable decarbonised energy system" (see here). Like the Royal Society, the UKCCC devotes much of its attention to hydrogen but it does look at other forms of storage and compares their efficiency and costs:

Table 2.1
Options for flexibility in a decarbonised power system

Option	Potential to be zero-carbon?	Techno-economic modelling assumptions				Status
		Duration	Efficiency (%)	Cost in 2035 (£2012)	Financial lifetime (years)	

Hydrogen							
New Build	Yes	Weeks-seasons	55	90 - 125	£/MWh	25	• Based on mature u gas technology but hydrogen versions r deployed at scale • UK projects planned including near indu clusters
Retrofit	Yes	Weeks-seasons	55	65 - 100		25	
Storage							
Batteries	Yes	Minutes-hours	85	260 - 980	£/kW	15	• Mature technology deployed at grid sc the UK
Pumped	Yes	Hours-days	85	1290 - 1830		30	• Mature technology deployed at grid sc the UK
Compressed air	Yes	Hours-days	60	860 - 1420		25	• Technology deploy overseas but not ye UK
Liquid air	Yes	Hours-days	60	900 - 1050		25	• Demonstrated but commercialised

Batteries are by far the cheapest technology at present, as owners of electric cars who use their batteries to store power generated by PV panels will know. The potential of batteries, however, is constrained by the availability of rare metals and their environmental impacts.

Setting batteries aside, what is significant from a Scottish perspective is that liquid air, such as is being proposed at Hunterston, can produce electricity for significantly less than PSH schemes like Earba. In fact PSH appears the most expensive short to medium term form of energy storage there is!. Developing schemes like Earba will therefore add significant amounts to most people's electricity bills and force even more people into fuel poverty.

There are of course various caveats to this.

First, the table gives the “financial lifetime” not the actual lifetime of PSH schemes. PSH dams will last far longer than 30 years or the technology used in liquid air generation. What matters in a private market, however, is the return to investors. They expect their investment and the profits to be fully realised within 30 years. That puts the price up. While state investment in PSH would be signficantly cheaper, it would similarly reduce the costs of liquid air.

Second, as hydrogen, compressed air and liquid air technology develops, their costs are likely to reduce significantly compared to PSH schemes which are very labour intensive (the Earba scheme will require 500 people to work on th project for over 5 years).

At present neither the UK nor the Scottish Government has been prepared to take a critical look at what’s best for consumers and are leaving it to the market. So much for Climate Justice! Given the rapid development of alternatives technologies like liquid air, however, the financiers have justifiably become even more nervous of investing in PSH. But two weeks ago they were offered a financial lifeline by the UK Government which promised investors in all forms of Long Duration Energy Storage a minumum income in return for a limit on profits in what is known as a “cap and floor scheme” (see here). The UK Government has not yet explained what that will mean for the prices consumers pay but the deal appears to take no account of the different costs of the various forms of storage.

The carbon costs of Earba

On 3rd June the Energy Consents Unit published, under the anodyne title of “ECU Correspondence (external)” a peat landslide assessment for Earba (see here). Normally such reports are provided by the developer but in this case the Scottish Government commissioned a report from Ironside Farrar. Although the report found there was no major risk of peat on the site sliding, it sets an important precedent for both the ECU and the wider planning system. First, given the sorry record of reports from so-called “independent” consultants who depend on developers to be paid, it should be government which commissions reports on the potential impact of developments. Second, if the ECU is concerned enough about peat to look into the risk of it sliding as a result of construction works, why hasn’t it also commissioned reports into how much carbon currently stored in peat would be released if the construction were to go ahead?

By extension, and far more importantly, why has the ECU not commissioned an independent report into the TOTAL amount of carbon which will be released into the atmosphere by the construction of this scheme and the time it will take for the renewable energy produced to compensate for these emissions? Among the carbon costs of the Earba PSH, which appear to be enormous, are the excavations, the concrete (which accounts for 8% of the world’s annual emissions of CO2 (see here)), the transportation of materials and the workforce to the area, the fabrication of the machinery and disturbance to soils.

If we are to make rational choices about energy storage, we need to be able to compare the carbon costs of PSH to that of both Liquid Air and Compressed Air storage. The costs of the alternatives appear likely to be significantly less because of factors such as their smaller scale, the higher proportion of the materials used which appear easily recyclable and because the schemes can be

located in places with much better transport links for both materials and labour. So why isn't government demanding answers to this if it is really committed to reducing carbon emissions?

The landscape impact of Earba

On 8th July, NatureScot the non-departmental public body with statutory responsibility for protecting nature and landscape, lodged an objection to the Earba scheme. The objection was based on the proposed development having a *"significant adverse effects (sic) the following wild land qualities of Rannoch-Nevis-Mamores-Alder WLA which we consider raise issues of national interest"*……the letter then listed three Wild Land Area qualities which would be affected. The critical point, however, was contained not in the main body of the letter but Annex A:

"We consider that these effects would be to the degree that this area would no longer contribute to the wider Rannoch-Nevis-Mamores-Alder WLA."

In other words the Earba development will DESTROY a significant part of the Wild Land Area. Anyone who knows the area and looked at the proposals or has read David Jarman's post will know that is correct.

NatureScot then made their objection worthless by stating this destruction could be mitigated by a "fully developed and detailed Restoration Plan" and by the Biodiversity Enhancement Plan and the Peatland Restoration Plan (both of which had already provided by the developer) *"which will lead to significant enhancement across the wider area."* Really?

NatureScot should know that Restoration Plans have become a complete and utter joke, particularly those required by the ECU. Regular readers will recall that a condition of the Beauly Denny powerline construction through the Drumochter was that the land was fully restored. Ten years later its still a massive eyesore and destroyed part of the Drumochter Hills Special Area of Conservation, supposedly one of Scotland's most highly protected areas, because neither the ECU, Cairngorms National Park Authority or NatureScot are prepared to take any action to enforce the planning conditions (see here for example) .

Two weeks ago I walked the ridge along Buachaille Etive Mor and looked down on the Allt Chaorainn hydro scheme in Glen Etive which I last blogged about two years ago (see here):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As the primary agency responsible for protecting the Wild Land Area and National Scenic area in which the Allt Chaorainn Scheme is located, NatureScot appears to have done nothing to get Highland Council to use its planning powers to restore this damage. It will be the same if the Earba PSH goes ahead. Developers know they can ignore Retoration Plans and whatever NatureScot says with impunity and that they can cut costs and increase profit levels by doing so. That is why run of river hydro schemes have left a swathe of destruction across Scotland.

As for claiming that wild land and landscape destruction can be mitigated by peatland restoration and "biodiversity enhancement", they are two different things. The one cannot compensate the other but in any case, just how NatureScot believes the replacement of Lochan na h'Earba with a reservoir – the constant varying water levels will destroy it as a habitat for wildlife – is beyond comprehension.

The justification NatureScot give for their position is *"the strategic importance of this scheme in meeting Scottish Government renewable energy targets".* In other words NatureScot has abandoned the things for which is it is responsible, including the protection of wild land and landscape, for something that is not, renewable energy targets. That is just wrong. For good decisions to be made, we need bodies like NatureScot and SEPA to keep to their remit and advocate for what they are responsible, leaving decisions about how to balance conflicting objectives to others.

What NatureScot could have usefully been doing, when assessing the landscape impacts of Earba and other PSH schemes, was comparing those impacts with the alternatives for energy storage:

The facility will be based at Hunterston *(Image: Highview Power)*

Which is preferable, the large Earba scheme in an area of great natural beauty or the much smaller Hunterston Liquid Air scheme on a brownfield site? Shouldn't NatureScot be telling the Scottish Government that Liquid Air could provide a way of bringing brownfield sites back into use without sacrificing some of Scotland's finest landscapes?

Concluding thoughts

I am not (yet) against all PSH and have previously argued that instead of leaving it to the market we should take a planned approach in deciding where such schemes should be located. That should include considerations of where they would have least impact on the landscape and natural environment.

The argument for that has now been considerably strengthened by the rapid development of new means of storing energy in the short and medium term, with compressed air and liquid air storage effectively providing all the same functions as PSH. Not only that, but the evidence suggests Liquid Air is significantly cheaper and the construction of the infrastructure required may well release far less CO2 into the atmosphere. While commentators like the Royal Society believe we need a mix of short and medium term storage – and I would agree with that until Liquid Air has been proven to work at scale (Compressed Air has been proven to work in other parts of the world) – the rapid development of these technologies should tip the balance against schemes like Earba. .

Instead of assuming all PSH are a good thing therefore – like NatureScot did in their response to Earba – we should be taking a far more critical approach and could safely reject schemes that cause significant amounts of damage to the landscape.

Since the Starmer government came to power it has made a host of announcements about investment in renewable energy. Last week, for example, it signed an agreement with the Scottish Government about the role Great British Energy will play in Scotland (see here). Unfortunately, neither government as yet has shown that they are capable of taking a critical or strategic approach to the need for electricity storage.

Arguably the main economic idea of the new Labour UK Government, which appears shared by the Scottish Government, is to encourage private investment to create jobs. While they are right that investment, whether private or public, creates jobs as yet they have given far too little consideration to "what jobs" or their impact on the environment. After their "Investment summit" a couple of weeks ago, which John Swinney attended, Keir Starmer boasted of "£63bn coming into the country" (that included a number of investments agreed while the Tories were in power).

According to the latest Private Eye, £34.3bn of this is for developments associated with renewable energy but £23.5bn is for data centres – mostly linked to Artificial Intellence. These require considerable amounts of energy with recent estimates (see here) suggesting this could reach 35TWh of electricity by 2050. That appears anything but intelligent! The only way we are going to move from fossil fuels to renewable energy sources across the world and address climate change is if the rich countries reduce their energy consumption.

I hope I have demonstrated here that anyone who has so far accepted the need for PSH schemes because they sound green should think again. That includes the Scottish Government's ECU. There is no need to sacrifice some of Scotland's finest landscapes, like that around Lochan na h-Earba, to make renewable energy work.

Category

1. Other parts Scotland

Tags

1. climate change
2. landscape
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4. NatureScot
5. planning
6. renewables
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