

drax



Moving mountains:
energy storage for a secure
sustainable future



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At Drax we're enabling a zero carbon, lower-cost energy future, with an ambition to become carbon negative by 2030.

Drax provides the single largest source of renewable power in the UK, generating reliable, flexible and dispatchable power even when the wind doesn't blow and the sun doesn't shine.

With a £2.5bn UK investment plan to enhance grid stability and boost energy security, our next chapter will ensure Drax plays a crucial role in reaching net zero and supporting jobs and industries nationwide.



✓ **£2.5bn**

We're investing £2.5bn in enhancing grid stability, boosting energy resilience, and positioning the UK as a global leader in carbon removals and pumped storage hydro. Through pioneering green technology and innovation, we're planning to help the UK decarbonise, creating a path to net zero and beyond.

At this critical time for the UK, Drax is supporting the country by:



Boosting UK energy security



Creating and supporting thousands of jobs across the UK



Pioneering bioenergy with carbon capture and storage (BECCS) to help the UK decarbonise



Making the UK a global leader in climate-saving technologies



Ensuring efforts to achieve net zero are affordable



Learn more about how Cruachan is helping to keep the lights on while creating jobs and growth

drax.com/cruachan2

Introduction to Cruachan

Renewables are essential to supporting energy security and further decarbonising the grid at a lower cost.

The UK Government has been working to increase renewable capacity for the country's grid, including plans to power every UK home by offshore wind by 2030, and to fully decarbonise the UK's power grid by 2035. This is a bold and necessary step, but we must be cognisant of the nature of the power that wind and solar bring to the grid.

Intermittent power sources – such as wind or solar – only generate electricity when conditions are optimal.

A grid overly reliant on these sources can fall victim to unfavourable weather conditions, leading to too little or too much power generation – risking blackouts, or requiring electricity generators to be paid to stop producing power, which is costly.

Through providing vital storage to reduce renewable power going to waste, pumped storage hydro is an essential component to ensure our grid is not only greener, but stable, affordable and flexible.



✓ **Over 1GW**

The generation capacity of 'The Hollow Mountain' after expansion, which is enough to power over two million homes.



Will Gardiner
Drax Group CEO

"These plants play a critical role in stabilising the electricity system, helping to balance supply and demand through storing excess power from the National Grid. When Scotland's wind turbines are generating more power than we need, Cruachan steps in to store the renewable electricity so it doesn't go to waste."

Today, 'The Hollow Mountain', located in Argyll and Bute, Scotland, has a capacity of 440 megawatts (MW) – enough to power almost 1 million homes.

Affectionately known as 'The Hollow Mountain', Cruachan is one of only four pumped storage hydro stations in the UK. The station has a capacity of 440 megawatts (MW) – enough to power almost one million homes – and can store up to 10 million m³ of water at any given time. It only takes 30 seconds for Cruachan to reach full generating capacity. Sitting on the northern shores of Loch Awe in Argyll and Bute, Scotland, one of the wettest areas in Europe, Cruachan is ideally located to support the UK's energy needs when required.

Drax wants to go even further and unlock the UK's full dispatchable and renewable potential by expanding Cruachan pumped storage hydro plant, which would more than double the site's generating capacity to over 1 gigawatt (GW) – enough to power over two million homes. This would not only support the UK's renewable targets by enabling more wind and solar to connect to the grid, but would also deliver cumulative savings of more than £350 million to consumers as the grid continues to decarbonise.

We're making great progress to deliver it. In July 2023, Drax was granted consent under Section 36 of the Electricity Act 1989 from the Scottish Government, a crucial delivery milestone towards building Britain's first new pumped storage hydro plant in a generation. Now, with the right support from the UK Government, Drax will invest c.£500m to more than double Cruachan's generating capacity and support almost 1,000 jobs across the supply chain during construction.

The UK has led the world in the transition from fossil fuels to renewable power and Scotland has been at the forefront of this renewables revolution. However to support energy security and further decarbonisation of the grid at a lower cost, the country will need more energy storage provided by pumped storage hydro – and Drax is ready to help deliver it.

How does pumped storage hydro work?

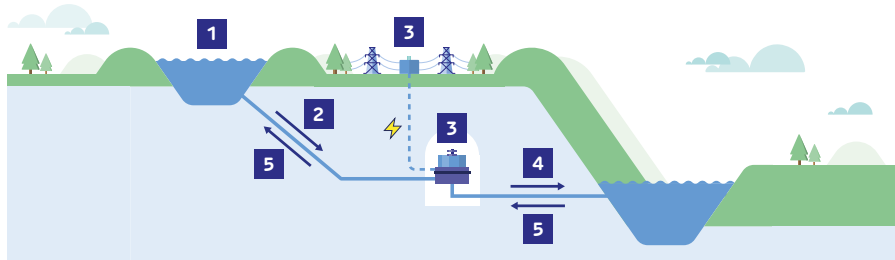
Pumped storage hydro is based on two water reservoirs at different elevations on a steep slope.

When there is excess power on the grid or demand for electricity is low, power is absorbed from the grid and used to pump water from the lower to the upper reservoir through reversible turbines.

When demand is high, the water is released downhill into the lower reservoir, driving the turbines in the other direction to generate electricity.

Pumped storage hydro facilities act as vast 'water batteries', offering a flexible, efficient and cost-effective way of storing excess energy generated by renewables at scale. Pumped storage hydro has been used for more than 50 years in the UK and accounts for more than 99% of global bulk energy storage solutions.

Cruachan power generation cycle



1. Cruachan's upper reservoir – nearly 400m above sea level – can store up to 10 million m³ of water, held back by a 316m dam across a 'corrie' (horseshoe-shaped valley).
2. When there's demand for electricity, Cruachan gets ready to generate by using underground pipes to flow water from the upper reservoir to the turbines inside the mountain.
3. The water spins the turbines, activating the generators that produce the electricity. Transformers convert the generated voltage to the transmission voltage, so the pylons above the surface can deliver the power where it's needed.
4. After spinning the turbines, the water goes down a tunnel to Loch Awe, the lower reservoir.
5. To refill the upper reservoir, Cruachan uses power from National Grid to drive the turbines. Acting as pumps, they send water from Loch Awe to the upper reservoir.



Why we need to expand Cruachan Power Station

Intermittent power sources like wind are key for countries to meet their climate goals but pose stability challenges for power grid operators.

The challenges we face

As the UK moves toward net zero emissions, low carbon and renewable power sources will become the norm. However, it's not as simple as swapping in renewables for the fossil fuels the grid was built around.

Many renewables are intermittent. For example, wind can produce just over a quarter (26.8%) of the UK's energy, as it did across 2022, but on single days when the wind doesn't blow this figure can be less than 10%.

A further challenge is transporting renewable energy to the consumer. As the UK's electricity system continues to change, so do its requirements for transporting energy. The switch from a few very large power stations to a greater variety of electricity sources, including wind and solar, means that there is a need for services to balance the subsequent variety in frequencies and voltage to the grid to keep it stable.



✓ **£929m**

This is the estimated total cost to consumers of wind curtailment and subsequent purchase of gas-fired power to make up the shortfall in 2022. Pumped storage hydro can help address this.



The knock-on effect

When network constraints mean that intermittent energy sources cannot be safely transported across the grid at the right frequency and voltage, intermittent energy generators need to be paid to turn off their services. This means that excess renewable energy generated in one area, such as Scotland, cannot be transported to high demand areas, such as those in England.

This is a highly inefficient way to run a power grid. In 2020 and 2021, there was a total wind power curtailment (total wind power wasted because it couldn't be transported to the right areas) of 5.8TWh – enough wind power to supply around 800,000 homes. This problem is particularly prevalent in certain areas, for example in Scotland, where 88% of this wind curtailment took place.

On days where intermittent service providers turn off their services, carbon-intensive gas generation typically needs to be turned up to compensate, resulting in higher carbon emissions which compromises long-term efforts to deliver UK net zero by 2050.

A secure solution

Pumped storage hydro is an essential component to ensure our grid is not only greener, but stable, affordable and flexible.

When called upon, Cruachan can reach its maximum output in 30 seconds to provide flexible power to stabilise the grid. And it works – the facility has been supporting the UK's energy security for over 50 years.

Why we need a Cruachan expansion

The secret to enabling a net zero electricity system, powering an additional one million homes, and creating hundreds of jobs.

A vital supporting role

As the electricity system transforms through a range of low-carbon and renewable technologies, the amount of energy storage on the UK grid will need to expand from 3GW today to over 30GW in the coming decades. National Grid, who manage the UK's electricity network, estimate that by 2030 at least 13GW of new electricity storage capacity will be required on the system to meet the challenge of intermittency from wind and solar. New pumped storage hydro is expected to play a significant role in providing this additional storage capacity.

Pumped storage hydro power stations require very specific sites, with substantial bodies of water between different elevations, to deploy. There are hundreds, if not thousands, of potential sites around the UK, including disused mines, quarries and underground caverns, but the cost of developing entirely new facilities is large.

A more cost-effective way to increase storage capacity is by expanding existing plants, such as Cruachan.

Creating jobs for the community

Our planned expansion of Cruachan will more than double the site's generating capacity to over 1GW of flexible dispatchable power. The construction and operation of the expansion will directly create 300 jobs over the five-to-six-year construction period and support a total of nearly 900 jobs across the wider supply chain in Scotland – not to mention provide a range of ancillary grid services, such as inertia, that help keep the network stable.

 **900**

Jobs created across the supply chain from expanding Cruachan.



Claire Mack
CEO Scottish
Renewables

“The Cruachan extension is a really exciting project and one that’s really important for Scotland. It brings together a number of our really important skills – civil engineering and electrical engineering skill sets too. What we really want to see is a renewables industry that’s thriving but also driving economic gain in Scotland. Pumped storage hydro has been part of Scotland’s energy story for over 100 years, particularly Cruachan, which is incredibly unique and special within the landscape.”



Delivering the Cruachan expansion

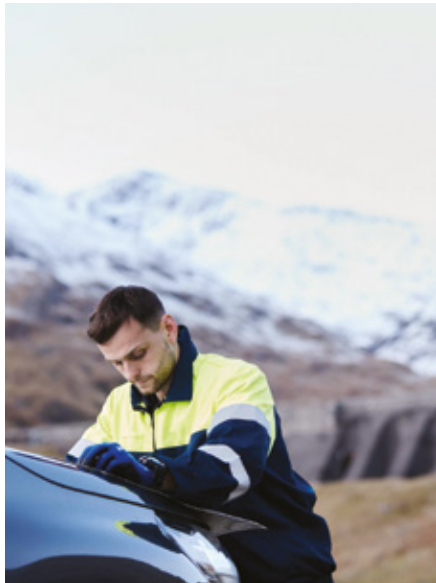
Drax is aiming to be a leader in UK dispatchable renewable energy generation and the expansion of Cruachan is at the heart of that objective.

Expanding our capabilities

The development – which could be the UK’s first newly constructed plant of its kind in more than 40 years – seeks to optimise the use of the existing Cruachan Reservoir and Dam through the creation of a new underground power station and associated infrastructure.

The development would provide an expansion of the power generation capacity with a second pumped storage hydroelectric generation station which would operate independently from the existing Cruachan station.

We’re aiming to have the Cruachan expansion operational by 2030, but that will rely on the right policies and commitments from Government to instil investor confidence in this large infrastructure project.



2030

The Cruachan expansion is fully operational, supplying flexible power to the grid and boosting the UK’s energy security.

Supporting this ambitious project

In July 2023, Drax received planning consent under Section 36 of the Electricity Act 1989 from Scottish Ministers.

Scottish First Minister Humza Yousaf said that the “expansion of Cruachan will help to strengthen our energy security by providing much needed resilience in the system, supporting hundreds of jobs and providing a real boost to the Scottish economy.”

Alongside a successful Section 36 application, the project will also require an updated policy framework to support large-scale long-duration storage and flexibility technologies from the UK Government.

The current lack of a framework for these technologies means that private investment cannot be secured in new pumped storage hydro and other projects, with no new plants built anywhere in the UK since 1984 despite their critical role in decarbonisation.

With an updated revenue stabilisation mechanism from the UK Government, work to build the new pumped storage hydro power station could get underway in 2024, with the project becoming fully operational by 2030. Drax is aiming to be a leader in UK dispatchable renewable energy generation and the Cruachan expansion is at the heart of that objective.

How does it work?

Key components of the proposed development include:

- ✓ Control works at Cruachan Reservoir and Loch Awe to create intakes/outfalls
- ✓ A new underground waterway system to carry water between the upper and lower reservoir
- ✓ A series of underground power-house caverns containing reversible pump-turbines and motor-generators
- ✓ Above ground substation to provide a connection between the existing 275 kilovolt (kV) circuit that connects to Dalmally substation
- ✓ Ventilation shafts
- ✓ New quayside on Loch Awe adjacent to proposed lower control works
- ✓ Above ground administration and workshop buildings for day-to-day operations
- ✓ Access tunnels for health and safety and movement of power station personnel
- ✓ Upgrades to existing service roads to facilitate access by heavy machinery

Cruachan past, present and future



Tom Johnston, Wartime Secretary of State for Scotland, pushes Cruachan through Parliament.

A workforce of 1,300 men, affectionately known as the Tunnel Tigers, starts construction. They set world tunnelling record of 560ft driven in 7 days during construction.

do.co.mo.mo.
international

Docomomo lists Cruachan as one of the sixty key monuments of post-war Scottish architecture.



Cruachan marks 50 years of service. A BBC radio documentary 'Inside the Rock', documenting its construction, is released to mark the occasion.

Drax applies for planning permission to expand Cruachan and help meet the UK's energy needs.



Sir Edward McColl, pioneer of hydropower in Scotland, conceives the idea for Cruachan Power Station.

James Williamson begins designing Cruachan.

Cruachan receives the Institution of Mechanical Engineers' Engineering Heritage Award.

Institution of MECHANICAL ENGINEERS

Cross-party group of MSPs writes to the UK Government calling for the implementation of the cap and floor mechanism.

Drax receives planning permission from the Scottish Government to expand Cruachan.

Drax acquires the portfolio of flexible, low carbon and renewable assets, including Cruachan Power Station as well as other sites across the UK.



Queen Elizabeth II opens Cruachan.



“This is a major milestone in Drax’s plans to build Britain’s first new pumped storage hydro plant in a generation. These plants play a critical role in stabilising the electricity system, helping to balance supply and demand through storing excess power from the National Grid. When Scotland’s wind turbines are generating more power than we need, Cruachan steps in to store the renewable electricity so it doesn’t go to waste.”

Will Gardiner
Drax Group CEO



77% of respondents to Drax’s public consultation welcomed the proposals for expanding Cruachan Power Station.

Responses included:

- ✓ The scheme will help to meet the growing national energy demand
- ✓ Pumped storage will be increasingly important as renewable energy generation increases
- ✓ More large-scale energy storage – such as Cruachan – and small-scale pumped storage hydro schemes are needed
- ✓ Great project and valid in light of the drive towards net zero ambitions
- ✓ Potential local supply chain benefits (such as the use of hotels in neighbouring towns and villages for workers during the construction phase)

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Learn more about how Cruachan
is helping to keep the lights on
while creating jobs and growth
drax.com/cruachan2