SCOTTISHPOWER RENEWABLES

Whitelee Solar / Hydrogen / BESS

PIE Summary
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INTRODUCTION

ScottishPower Renewables (UK) Limited (SPR) is developing an exciting and highly innovative project directly adjacent to the UK's largest onshore windfarm at Whitelee, on the outskirts of Glasgow.

SPR's proposal is for the development of a combined solar PV farm, green hydrogen production facility and Battery Energy Storage System (BESS) (together the 'Development') located at East Kingswell, immediately to the northwest of Whitelee Windfarm (the 'Site'). The solar PV and green hydrogen production facility are located largely within the area previously considered for windfarm development as part of Whitelee Windfarm Extension Phase 3.

The solar PV farm will provide renewable electricity to the green hydrogen production facility, while the BESS will provide electrical stability for the Development and the wider electricity network.

Key Development Details

Element	Size/Capacity	Output
Solar PV	62,000 solar PV panels	~ 20MW
Green Hydrogen Production Facility	100x120m compound	10,000kg/day
BESS	100MWh	50MW

Project Background

As announced in September 2020, ScottishPower Renewables is part of a pioneering partnership to create new green hydrogen production facilities with clusters of refuelling stations across Scotland, supporting the country's efforts to achieve net zero by 2045.

'Green Hydrogen for Glasgow' is a partnership designed to provide carbon- free transport and clean air for communities across the city, which wants to become the first net-zero city in the UK by 2030. It also supports the Scottish Government's decarbonisation targets and Glasgow City Council's commitment to creating a zero-emissions vehicle fleet, using only electric and hydrogen powered vehicles by the end of 2029.

This project will use solar energy to power a green hydrogen production facility, which will create hydrogen fuel for zero-carbon vehicles as part of Green Hydrogen for Glasgow. The Development's location on the outskirts of Glasgow and close to the M77 means that it is perfectly situated to support this goal and help deliver clean, green hydrogen, utilising both existing and new renewable assets.

Renewable energy production is very dependent on weather conditions - for example, wind speed at a wind farm, or cloud density over a solar site. There are times where renewable generation might be high but demand for that electricity is low, and vice versa. As we move away from consistent but carbon-intensive sources of generation (like coal burning) and towards more variable renewable sources, we need a way to smooth that variance out and ensure that the supply of electricity always matches the demand.

Battery Energy Storage Systems (BESS) allow excess generation to be stored when demand is low and used later, rather than that electricity being wasted. Batteries are green technology and produce no emissions or pollution during normal operation. As battery storage technology can react to changes on the network very quickly it can also provide stability services to the Grid during generation/demand fluctuations, which will reduce the incidence of power cuts and ensure that electricity supplies remain stable.

Site Selection

The following factors fed in to the selection of this site to host the Development:

- Acceptable solar yield during peak months
- Excellent site accessibility and access from the motorway network
- The lack of statutory nature conservation designations on the site
- Good ability to locate infrastructure away from local residents
- A good landscape fit
- Efficient use of existing infrastructure, including the existing grid connection point at Whitelee Extension Substation.

DEVELOPMENT OVERVIEW

Solar

The solar PV farm will comprise c. 65,000 solar panel arrays each with heights of up to 3m at the frame's highest point. The solar PV farm will include inverter stations, site tracks, perimeter fencing, CCTV cameras, a new access via the B764, and a substation building on the same platform as the green hydrogen production facility.

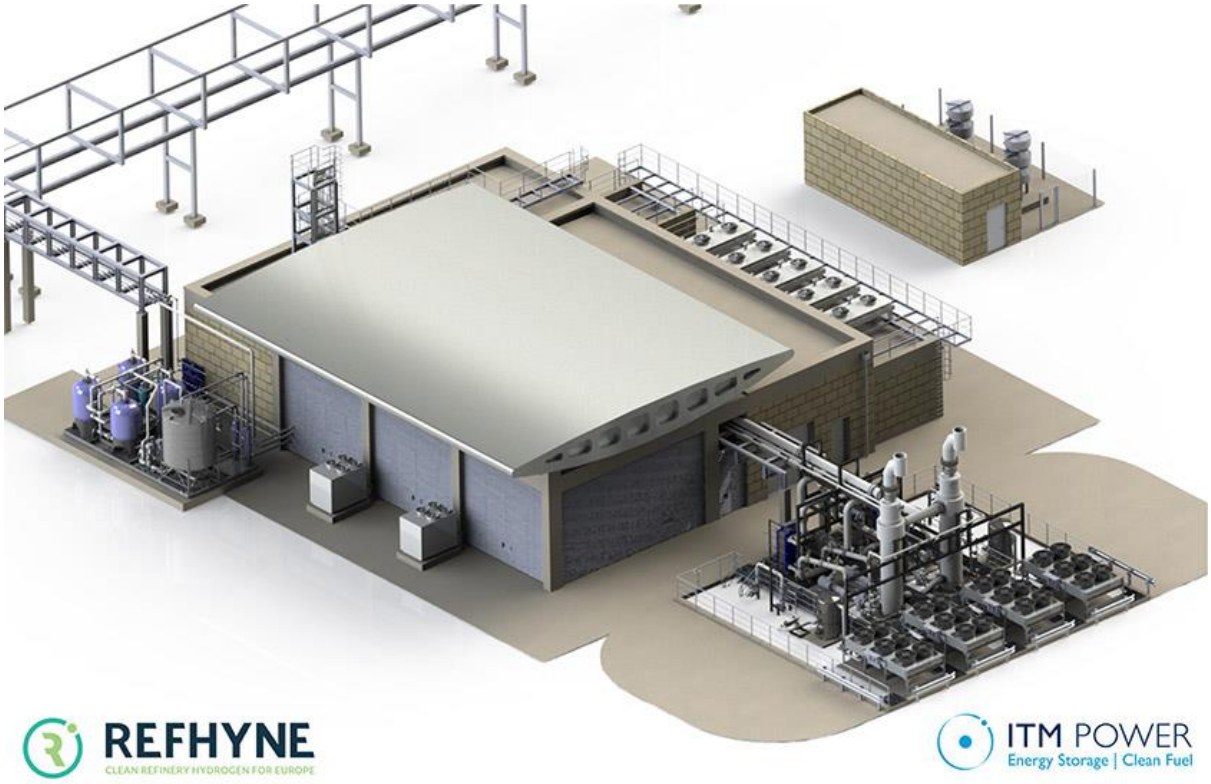
The area chosen for the solar PV farm will allow the solar PV arrays to be arranged in such a way that they are integrated into the landscape while still facing the sun at an optimal angle, providing maximum solar yield and requiring minimal changes to the existing topography of the site.

Above: Typical solar panels and mounting

Green Hydrogen Production Facility

The green hydrogen production facility is embedded within the solar PV farm area and shares a platform with the substation building for the solar PV farm. The facility will be accessed via the solar PV farm's access tracks, with a secondary access proposed to the east of the site joining on to the existing Whitelee Extension link road. The facility will consist of multiple buildings, pressure vessels, pumps/compressors and storage tanks, all interconnected by a network of pipework and cabling.

The facility uses Polymer Electrolyte Membrane Electrolysis technology, and will be able to produce up to 10,000kg of green hydrogen per day based on a 20MW initial power demand. The facility requires 120,000 litres of water per day and will have a dedicated mains water supply.



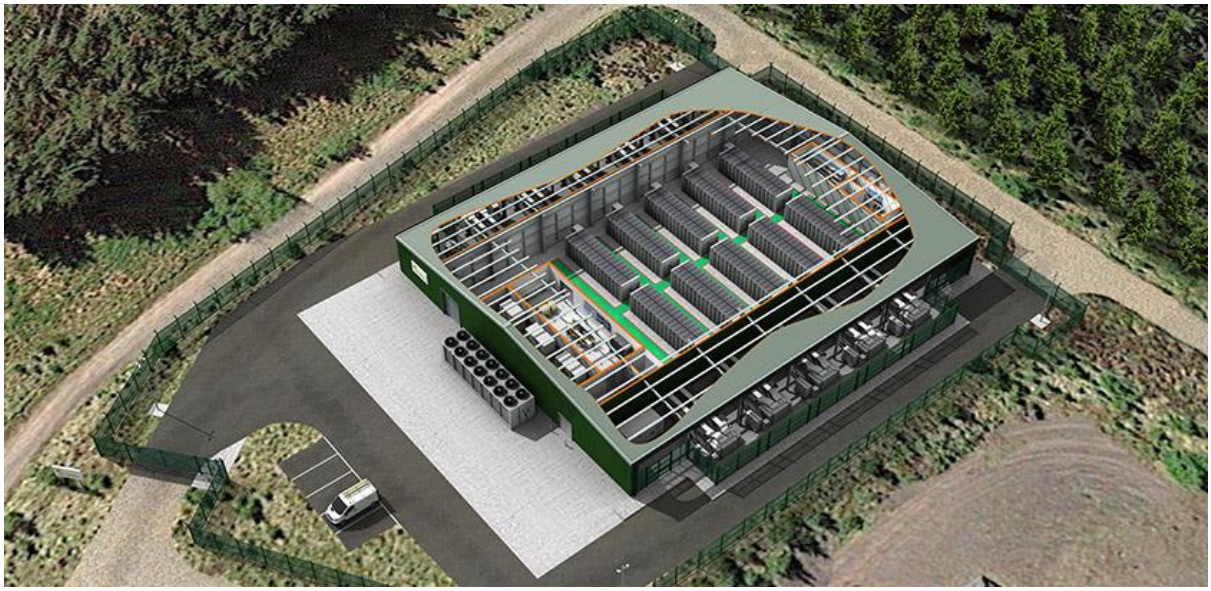
Above: Indicative image of the Refhyne project, a 10MW Hydrogen production and storage facility with similar technology, showing what the Facility could look like.

Image courtesy of ITM Power.

BESS

The BESS uses established Lithium-Ion battery technology and will be housed in a single storey building approximately 70mx63m. Like the solar PV farm, the BESS compound will include associated infrastructure; inverters, fencing, CCTV, an auxiliary supply kiosk for the local LV supply, and fire suppression equipment.

The BESS compound will be situated next to the existing Whitelee Extension Substation and will utilise existing access roads.



Above: Representative image of the BESS currently under construction at Whitelee BESS, showing what the BESS in this Development could look like

ENVIRONMENTAL CONSIDERATIONS

Ecology, Ornithology and Nature

Understanding the potential for a development to impact on habitats, birds and other species is an important part of scheme design.

We have…

- Undertaken a series of desk-based studies to identify existing records of species and habitats;
- Undertaken baseline ecological surveys on site for protected species and habitats; and
- Undertaken baseline ornithological surveys.

We found…

There are no nationally important sites of nature conservation value within or near the Development. Three non-statutory designated sites are located within 1km of the site:

- Fenwick Moor (Greenfield Burn) Provisional Wildlife Site is located within the site;
- Craigendunton Reservoir Provisional Wildlife Site is approximately 350m from the site; and
- Lochgoin Reservoir and Dunwan Dam Site of Importance for Nature Conservation (SINC), is approximately 1,300m from the site.

A large proportion of the Site comprises wet modified bog/blanket mire, coniferous plantation woodland, and areas of improved, semi-improved and marshy grassland. Recent surveys indicate that the blanket mire has been adversely impacted by commercial forestry plantation, grazing pressure, and drainage. The southern section of the Site comprises former coniferous plantation woodland, which was clear-felled in 2008 and has since been subject to phased restoration.

The following protected and priority species have been surveyed:

- No evidence of badger, water vole, or bat roosts have been identified within 100m of the Development;
- Otter activity has been recorded within localised areas including the presence of covered and uncovered temporary resting sites;
- Bird species of high conservation importance (hen harrier, merlin, peregrine, short-eared owl, barn owl and golden plover) are present in the wider area but do not appear to use the site for breeding. Small numbers of black grouse are present in the

wider vicinity, with two historic leks approximately 900m and 1,300m from the Development; and
- No migratory salmonids (sea trout or Atlantic salmon) are known to be present in the five minor watercourses that are located within the footprint of the Development; however, brown trout (non-migratory salmonids) are likely to be present in all of them.

What we propose to do…

SPR will seek to mitigate impacts on ecology by:

- Avoiding construction during the bird breeding season where possible, or where not possible undertaking surveys to identify and protect any nesting birds;
- Avoiding watercourses and areas of sensitive blanket bog habitats identified;
- Adopting safe working buffers where protected species are found; and
- Adopting pollution control measures to prevent silt or dusts entering watercourses.

Any potential adverse effects for any species will be mitigated, with species-specific mitigation plans created where required.

Geology, Hydrology and Hydrogeology

Our understanding of the ground conditions and surface water network has informed the site design and layout. We want to ensure that the potential effects of the Development on hydrology and related habitats and species are considered holistically, and that negative impacts on ground and surface water are minimised.

We have…

- Assessed watercourses on the Site and avoided them as far as possible in the design process;
- Investigated peat depths across the Site; and
- Identified the location of private water supplies near the Site and the potential for flooding from Site watercourses.

What we propose to do…

Watercourse layout and runoff patterns have been considered during the design of the Development, and watercourses have been avoided as far as reasonably possible.

Peat surveys identified peat deposits of variable depth across the Site, including areas where there is no peat present. The designs for the solar PV farm and green hydrogen production facility avoid areas of deep peat and concentrate development on areas with little or no peat. Where peat cannot be avoided, mitigation measures have been set out as part of the planning application.

The design for the Development avoids works that could impact private water supplies in the area. Private water supplies will be monitored to ensure that the Development has no inadvertent impacts.

Transport and Access

We have…

Undertaken an assessment of the potential impacts of the Development on access, traffic, and the local transport network, in relation to both the construction and the operation of the Development.

What we propose to do…

A Traffic and Transport Assessment was included as part of our planning application for the Development. New access roads are required for the solar PV farm and green hydrogen production facility. We found that the road network surrounding the Development had sufficient capacity to support the vehicle and access requirements of the Development without impacting other traffic flows.

Protecting Road Users and Residents during Construction

Traffic will increase during the construction of the Development. In order to minimise the impact on local residents and other road users, it is anticipated that a Construction Environmental Management Plan (CEMP) and a Traffic Management Plan (TMP) will be produced prior to construction. The following practices will be used:

- Erection of appropriate temporary signage in the vicinity of the Site warning of construction traffic and warning other users of abnormal load turbine movements;
- Ground preparation, including protection of services; and
- Arrangements for road maintenance, wheel washing and road sweeping where necessary.

Other Characteristics

Emissions, Air Quality and Climate Change	There are no adverse emissions to air or land associated with operation of any part of the Development. No chemicals or additives are introduced to the water used by the green hydrogen production facility. Suitable drainage systems will be implemented to manage this water. Water vapour is produced in limited amounts during hydrogen production and vented to the atmosphere. On cold days this may create visible plumes; however, these plumes are just water and have no impact on air quality. The Development will provide a secondary beneficial effect on air quality, by avoiding emissions which would otherwise be produced by other technologies (for example, allowing local transport to use hydrogen fuel rather than diesel).
Noise and Vibration	The Development is not considered to present a significant impact arising from noise and vibration. BESS and hydrogen production facilities of the type proposed do not generate significant noise during their operation. However, noise data for ancillary components at each compound (compressors, HVAC, etc.) will be analysed, and noise will be mitigated if required.
Health and Safety	There are no significant risks to human health identified in the context of the operation of the Development. Construction and operation will be compliant with all applicable Health and Safety Legislation (HSAWA1974, COSHH2012, CDM2015, etc.). The Development is not in a location which is susceptible to natural disasters or extreme weather.

Waste	The construction is unlikely to generate significant quantities of waste materials. The green hydrogen production facility will produce waste water, which can be drained to local sewers. Waste management will be further addressed within a future Construction Environmental Management Plan (CEMP) for the site.
Glint and Glare	A Glint and Glare Assessment was undertaken as part of the planning application to assess potential reflection from the solar PV farm, and the impact this could have on local users and aviation. No significant impact was found.
Historic Environment	There are several non-designated heritage assets located within 500m of the Development. Lochgoin Monument (Cat B Listed building) and Dunwan Hill Fort (Scheduled Ancient Monument) are within 5km of the Development. The Development's impact on local cultural heritage has been assessed as part of the planning application, and the Development will have no significant impact.
Resources and Socio-Economics	During construction 3 temporary construction compounds and several equipment laydown areas totalling c. 6,000 sq. m (0.6 hectares) will be required. During the operational phase of the development, most of the site will be returned to be used for grazing land. The Development will benefit local employment (particularly the green hydrogen production facility which requires dedicated staff) and will provide a wider service benefit to the local and wider economy by offering efficient green energy and fuel.

FAQS

General

1. **Will this affect public access to Whitelee?**

   We don't expect the development to affect the public access arrangements for Whitelee.

   During construction there may be some access restrictions in the immediate vicinity of construction sites, but as the sites are located away from main paths this should not significantly affect public access.

2. **When do you expect to begin construction?**

   We expect to begin construction in Q4 2021/Q1 2022. The green hydrogen production facility is expected to be fully operational by Q4 2023, with the solar PV farm and BESS completing a little before this.

3. **How will the development affect local roads?**

   We don't expect there to be any significant adverse impacts or changes to traffic flow on the local road network as a result of this development, either during construction or operation. During construction, there will be an increase in HGV and heavy plant traffic to and from the site.

   The operational entrance to the BESS will likely be via the existing Whitelee Windfarm and Extension entrance to the east of the proposed green hydrogen production facility. The link road runs south from the B764 and is designated as a private access road.

   Entrance to the green hydrogen production facility and solar PV farm will be via a new private access road to join the B764 at Kinsgwell, which we expect to build in early 2022. A secondary access to the green hydrogen production facility is proposed to the east of the site, joining the existing Whitelee Windfarm and Extension link road.

   We expect there to be 4-5 HGVs accessing the Green Hydrogen Production facility per day once it is operational. The other sites will not be regularly accessed, and we expect around 1-2 cars or small vans a week at each site for maintenance purposes.

4. **How do you plan to construct on peat?**

   Currently, we plan to use standard piles to support the foundations of any proposed structures. We will use adapted piling rigs and construction equipment which can traverse the bog safely to provide the initial foundations.

   Temporary access roads may be built across the bog to allow access to the development during construction.

5. **How do you intend to mitigate the environmental impact of the development?**

   We have taken care to avoid the most environmentally sensitive areas and deepest peat when planning this development where possible, but the proposal for the green hydrogen production facility does require construction in an area that is currently subject to a Habitat Management Plan (HMP). As part of SPR's ongoing commitment to protecting the sensitive peatland at Whitelee, we have proposed a new HMP that will protect a different area of peatland near the Development of at least equivalent size to the area being developed. The new HMP will allow us to mitigate the potential impact of the Development and will provide an opportunity to improve the conservation and condition of the designated area beyond this. The proposed HMP is of greater conservation interest than the land being developed.

   We don't expect there to be any additional impact on local wildlife, as detailed in the Environmental Impact Assessment and Planning Submission for this site.

   We consider the development to be a net benefit for the environment overall – creating green hydrogen from renewable electricity will allow large numbers of old diesel vehicles to be replaced, which will reduce pollution and improve air quality as well as significantly reducing the carbon footprint of the vehicles.

Hydrogen

1. **What is hydrogen fuel?**

   Hydrogen is the lightest known gas and is naturally found in small quantities in air. When hydrogen is burned as fuel it produces only water, unlike petrol and diesel which also create carbon dioxide, soot, and other chemicals and particulates which have a negative impact on the environment.

   Compressed hydrogen is an extremely dense energy source; a hydrogen tank can contain much more energy than an electric battery of the same size. This makes hydrogen a good ‘green’ fuel for large vehicles with high energy needs or which need to cover long distances, which would require prohibitively large and heavy batteries to run on electricity. Adapting heavy vehicle fleets to use hydrogen fuel instead of diesel is a critical part of decarbonising transport and reaching Net Zero by 2045.

2. **What is Green Hydrogen?**

   Green hydrogen is hydrogen that is produced without creating carbon dioxide as a by-product and using entirely renewable resources - water is split in an electrolyser which is powered by renewable energy. At Whitelee, green hydrogen will be produced using the electricity generated on-site by the solar panels and water from a dedicated supply.

   Other types of hydrogen are produced by Steam Methane Reformation (SMR), which heats steam and natural gas from fossil fuel together to produce hydrogen and carbon dioxide. Most hydrogen produced today is ‘grey’ hydrogen, where the waste carbon dioxide is vented directly to the atmosphere. There is also ‘blue’ hydrogen, which is also produced using SMR but which uses Carbon Capture and Storage (CCS) technology to capture the carbon dioxide created rather than emit it. Blue hydrogen is less environmentally damaging than grey hydrogen, but it is not carbon-free as it uses fossil fuel and the carbon dioxide it creates must be stored and managed indefinitely.

3. **Why Hydrogen in this location?**

   As announced in September 2020, ScottishPower Renewables is proud to be a partner in ‘Green Hydrogen for Scotland’ a pioneering partnership to create new green hydrogen production facilities with clusters of refuelling stations across Scotland, supporting the country’s efforts to achieve net zero by 2045.

‘Green Hydrogen for Glasgow’ is the first project being brought forward by the partnership designed to provide carbon- free transport and clean air for communities across the city, which wants to become the first net-zero city in the UK by 2030. It also supports the Scottish Government’s decarbonisation targets and Glasgow City Council’s commitment to creating a zero-emissions vehicle fleet, using only electric and hydrogen powered vehicles by the end of 2029.

The Development’s location on the outskirts of Glasgow means it is perfectly situated to support this goal, and help deliver clean, green hydrogen, utilising both existing and new renewable assets.

4. **How will it be produced at the site?**

The Green Hydrogen Production facility will contain an electrolyser, which uses electricity to split water into hydrogen and oxygen in a process known as electrolysis. Powering the electrolyser from renewable sources such as solar and wind power means the process is completed without any carbon emissions – resulting in ‘green’ hydrogen.

Electrolysis using renewable energy is currently the only way in which zero-carbon hydrogen can be produced. Other methods involve using natural gas or oil as a hydrogen source, which produces carbon dioxide as a by-product.

We initially plan to produce 6.6 tonnes of hydrogen per day, with the potential to increase this to 10 tonnes per day as demand increases.

5. **Will there be any emissions or pollution from the site?**

As the hydrolysers use renewable electricity to separate water into oxygen and hydrogen, no chemical or carbon emissions are produced at any stage.

Oxygen is produced as a by-product and will be vented to the outside of the facility, along with some water vapour. On cold days, a plume of steam may be visible as a result.

6. **How is the hydrogen stored and transported?**

After production, hydrogen is pressurised to 500bar (c. 7252psi) and stored in pressurised tanks. Current plans are for about 8,700kg of potential hydrogen storage across 8 tanks, although we expect that regular deliveries leaving the site will mean that the actual amount of hydrogen stored at any one time will be lower.

The hydrogen will be transferred into pressurised tubes, which will be picked up by specialised HGVs (known as Tube Trailers) and transported to local filling stations. Hydrogen powered vehicles will be able to fill their tanks at these filling stations.

7. **Is hydrogen safe?**

   Hydrogen is naturally found in small quantities in air and is very light. If it leaks, it evaporates immediately and does not produce any contaminants or pollution. If hydrogen ignites it quickly burns out and produces no harmful by-products and no residual heat or reignition hazard, unlike conventional fuels such as petrol or diesel. Hydrogen storage and transport is covered by existing fuel gas safety legislation, and the site is subject to the same regulatory and safety requirements as a natural gas or fuel storage facility.

Solar

1. **What is Solar PV Technology?**

   Photovoltaic cells directly convert sunlight into electricity. The term ‘PV’ comes from the process of converting light (photons) to electricity (voltage). Solar panels are typically made from solar cells that, once combined, create a single system referred to as a solar array.

2. **Why have we chosen this layout?**

   We have surveyed the entire site extensively over more than a decade and have decided on the proposed layout after detailed analysis of these survey results.

   The proposal:

- Avoids the deepest areas of peat at Whitelee;
- Provides a good solar yield;
- Avoids any tree-felling or other forestry;
- Is near to an existing access road, which is important for the co-located hydrogen facility; and
- Can be reasonably connected to the electrical Grid based on the infrastructure nearby.

3. **How big is the development?**

   We plan to install c. 62,000 individual solar panels across 7.5 hectares (c. 18.5 acres). Each individual panel will be no more than 3m tall and will be angled to catch sunlight effectively. During peak operation, this should produce around 20MW of electricity, which will be used to power the Green Hydrogen Production Facility.

4. **Don't the solar panels require constant sunlight/heat to produce energy**?

   Solar panels harness the energy in sunlight to produce electricity, and even on cloudy days there is enough light present to allow some electricity to be produced. Direct, intense sunlight will increase the output of the solar panels but is not needed for them to produce electricity. Solar schemes currently operate across the UK all year round, even in areas like Whitelee where weather conditions are very variable.

   We have carried out extensive energy yield assessments at the proposed site, which show that a 15-20MW Solar development at Whitelee would produce the electricity required to operate the hydrolysers at the Green Hydrogen Production Facility.

5. **How long do solar panels operate for?**

   PV arrays and systems have a typical lifespan of 30-40 years. Once operational, they require very little maintenance. They do require occasional washing to remove dirt and grime build-up on the photovoltaic surface of the panel, as this reduces their efficiency.

BESS

1. **Why Battery Storage Technology?**

   Renewable energy production is very dependent on weather conditions - for example, wind speed at a wind farm, or cloud density over a solar site. There are times where renewable generation might be high but demand for that electricity is low, and vice versa. As we move away from consistent but carbon-intensive sources of generation (like coal burning) and towards more variable renewable sources, we need a way to smooth that variance out and ensure that the supply of electricity always matches the demand.

   Battery Energy Storage Systems (BESS) allow excess generation to be stored when demand is low and used later, rather than that electricity being wasted. Batteries are Green technology and produce no emissions or pollution during normal operation. As Battery Storage technology can react to changes on the network very quickly it can also provide Stability services to the Grid during generation/demand fluctuations, which will reduce the incidence of power cuts and ensure that electricity supplies remain stable.

2. **Why here?**

   The location of the BESS site has been strategically chosen as it is within the Whitelee Windfarm boundary, within an existing construction compound used during previous extension works at Whitelee. This will minimise any additional environmental and visual impact.

   The compound is near the existing Whitelee Extension substation, providing an existing point of connection to the electrical Grid. This will reduce the need for large sections of cable to be laid and will allow us to connect to the Grid without constructing a new substation, which in turn will reduce the potential environmental and visual impact of the proposed development.

3. **How will the batteries work?**

   Approximately 100 individual Lithium-Ion cells will be housed inside the building at the battery site in banks of 10 cells. Taken together, this array provides 50MW of usable storage capacity.

   When Whitelee is generating more electricity than is required by the Grid, excess power will be diverted to the battery and stored until needed. When demand is higher than generation, or when the Grid requires additional support, the batteries will

discharge their stored electricity. The batteries can respond very quickly to changes on the network so are ideal for providing support services, unlike most other types of renewable generation which take time to power up.

The batteries will be regularly maintained and constantly monitored to ensure that they remain efficient and that any battery degradation is captured as quickly as possible. Assuming heavy use, each cell should last around 10 years before repair or replacement is required.

4. **Are batteries noisy?**

We have found that these types of sites, once constructed, do not disturb the surrounding area with noise. A noise assessment has been carried out to confirm whether there are any special requirements at this site for noise mitigation, as part of the planning application.

Although the batteries and associated equipment can produce noise during their normal operations, they will be housed inside a building, which will mitigate the impact of any noise outside the building and around the site.

5. **Are batteries safe?**

We currently plan to install Lithium Ion ("Li-Ion") batteries, along with associated inverters and transformers. Battery technology is well established in the UK, and safety requirements for equipment are well tested and robust. The batteries will be installed with the same electrical and thermal protective equipment and be subject to the same inspection, testing, and maintenance regime as other battery storage or generation sites. The battery storage building will have a dedicated HVAC (Heating, Ventilation & Air Conditioning) system to ensure that the building temperature remains within operational limits.

Research shows that the risk of fire or fault is low, but we have taken steps to ensure that the site is safe and well-protected. The battery storage building will house a gas detection and venting system, as well as a fire detection and suppression system supplied from a dedicated on-site water tank.