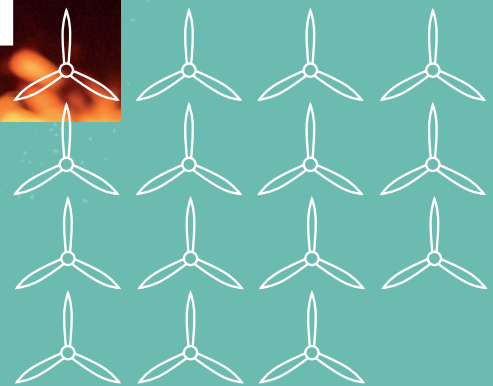


Building Shetland's energy future

SPRING 2023





About SSE Renewables

SSE Renewables is a developer and operator of renewable energy across the UK and Ireland, with a portfolio of around 4GW of onshore wind, offshore wind and hydro. Part of the FTSE-listed SSE plc, its strategy is to drive the transition to a net zero future through the world class development, construction and operation of renewable energy assets.

SSE Renewables owns nearly 2GW of operational onshore wind capacity with over 1GW under development. SSE Renewables also has the largest offshore wind development pipeline in the UK and Ireland at over 6GW, of which around 3GW is in construction or consented.



About Viking Wind Farm

Viking Energy Wind Farm (VEWF) is a 103-turbine onshore wind farm set around the central Mainland of Shetland. The £580m project is owned by SSE Renewables and construction began in the autumn of 2020.



TRANSMISSION

About SSEN Transmission

SSEN Transmission, operating under licence as Scottish Hydro Electric Transmission, owns, operates and develops the high voltage electricity transmission network in the north of Scotland. Its network consists of underground and subsea cables, overhead lines on wooden poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass crossing some of its most challenging terrain.

SSEN Transmission powers the communities its network serves by providing a safe and reliable supply of electricity, taking the electricity from generators and transporting it at high voltages over long distances through the transmission network for onwards distribution to homes and businesses in villages, towns and cities.

We are committed to inclusive stakeholder engagement, and conduct this at an 'Accomplished' level as assessed by AccountAbility, the international consulting and standards firm.

AA update

SSEN Transmission works to achieve the externally accredited AA1000 Stakeholder Engagement Standard. This is considered the 'gold standard' in stakeholder engagement accreditation. Our AA1000 Stakeholder Engagement Standard score as of June 2022 is 82% with a top-tier rating of "Advanced" in the AccountAbility Stakeholder Engagement Maturity Ladder. This is a 20% increase on our 2019/20 score and demonstrates our commitment to continuously improving our stakeholder engagement practice.

Keeping in touch

We are keen to hear your feedback, so if you have any questions about the newsletter or the works currently underway please contact:

SSEN Transmission Community Liaison Manager Thea Groat thea.groat@sse.com / 07901 127 205

Viking Wind Farm Community Engagement Manager Julie.Graham2@sse.com / 07586 282236

To find out more about the projects and to register for updates please visit:

www.ssen-transmission.co.uk/projects/Shetland/

www.vikingenergy.co.uk/

Construction update: Turbine Components Arrive on Site



A turbine component convoy heading through Girtsta.

Readers of a certain vintage will remember that old Saturday night favourite the A-Team and Hannibal Smith's catchphrase, "I love it when a plan comes together". That phrase sums up everyone's feelings when another huge project milestone for the Viking Energy Wind Farm (VEWF) was reached on 6 February 2023 – the successful first delivery of wind turbine components, by convoy, from the Greenhead Base in Lerwick to the VEWF site. The first convoy delivery went very smoothly and took around 35 minutes.

VEWF will consist of 103 Vestas 4.3MW turbines. Each wind turbine is assembled from ten sections. The table below lists the sections and their weights for transportation and erection. The components are delivered on specialized trailers which have multiple axles, thereby helping to minimize the axle weights along the route between the Lerwick Port and their final locations around the VEWF site (which has 70km of internal tracks – all long since geographically completed).

The components with the largest dimensions are the blades at ca 60m long. Again, these have specialist bespoke trailers which include remote-controlled turning axles at the rear to allow them to successfully traverse tight bends.

The name for deliveries involving these kinds of weights and dimensions is Abnormal Indivisible Loads (AILs). They are transported in convoys, complete with escort vehicles, including two specialist police traffic units who Police Scotland have drafted in from Mainland Scotland. In total 15 – 20 personnel are actively involved in each convoy.

The frequency, timing and route planning of the convoys is the result of many months of careful planning and discussion, principally with Police Scotland, the SIC (Roads Authority) and with Vestas' specialist transport sub-contractor, McFadyens. Petersons at Greenhead Base are responsible for the cargo handling and storage logistics, with over 50 people involved in their operations there, with a significant number of staff having been added to handle

Component	Weight
Base	75,000 kg
Mid 1	67,000 kg
Mid 2	57,000 kg
Top	44,000 kg
Blade 1	16,000 kg
Blade 2	16,000 kg
Blade 3	16,000 kg
Nacelle	66,876 kg
Drivetrain	65,817 kg
Hub	32,535 kg
TOTAL	456,228 kg

Vestas' shipments.

Convoy timing details

- There will be up to three convoys per day, 6 days a week (Mon – Sat) with up to four wind turbine components per convoy.
- Convoy travel time is estimated to be up to 1 hour from leaving the port to entering the site, although the first convoy took just over half an hour to reach its destination
- The time windows when the convoys are expected to leave the port on weekdays (Mon-Fri) are between: 6am – 7am; 11am - 12noon and 1pm – 2pm

The times the convoys are expected to leave the port on Saturdays are between 6am – 7am; 10am – 11am and 12 noon – 2pm.

The timing of the movements has also been planned to seek to ensure that the early morning convoy will be off the public highway by 8am and the mid-afternoon convoy will be off the public highway by 3pm to avoid the relevant peak travel periods. Ultimate command of the convoys sits with their Police Scotland escorts and decisions, such as stopping at strategic points to allow any traffic build-up to pass, will be down to those experienced Police Scotland

Officers, depending upon the circumstances prevailing on any particular day.

Turbine erection

The process to begin assembling the turbine components begins with the bottom two tower sections being lifted into place. In another significant project milestone, the first sections were lifted into place on 1 March 2023, to the east of Scar Quilse in North Nesting. Once a number of these lower sections are in place, then a larger crane will be mobilized to begin the higher lifts to fit the top two tower sections; nacelles; drivetrains (gearboxes and generators); hubs (which the blades are attached to); and the blades (three in each finished turbine). It is expected that the first fully erected turbines, with all these components fitted, will start to appear on the site landscape next month i.e., April 2023 – another hugely significant milestone to come soon.

Direct local spending, now close to £53 million

Shetland contractors, suppliers and employees are continuing to directly benefit from wind farm construction. Direct construction spend with the local supply chain now stands at around £53 million, a figure which continues to rise daily. There are now around 70 local suppliers engaged, including 26 local contractors directly involved on site. VEFW remains steadfastly committed to supporting the Shetland, Scottish and wider UK supply chains during project delivery, and is creating around 400 jobs at peak construction (and heading towards 600 when the separate HVDC link project is factored-in). Turbine supplier Vestas is now also awarding contracts and recruiting long-term local operations and maintenance teams, including apprentices. One to one engagement between Vestas and the local supply chain continues, with an ongoing commitment to securing local supply wherever possible.

As the civil construction works start to tail off through 2023, RJ McLeod's workforce will start to reduce accordingly, but will continue to be replaced by Vestas and its sub-contracted turbine erection teams, and related supervisory staff, with around 200 specialist staff being in place by the end of April. The bulk of Vestas' staff and sub-contract workers are expected to stay at Sellaness, with plans for a floating accommodation barge in Lerwick now superseded.

What's happening elsewhere on site?

With the final turbine base having been poured and completed in early November last year, backfilling of those bases is now also completed, with just the top parapet of



First two tower sections bolted into place, North Nesting. The first fully erected turbines are expected in April.



Turbine nacelles being stored at Greenhead Base, Lerwick, prior to delivery by convoy.

anchor fixing bolts now showing above ground level, all sitting ready for the bottom turbine tower sections to be attached.

The VEFW site is split into sixteen different turbine arrays and, ahead of programmed deliveries of turbine components, there is an ongoing sequenced capping of crane pads/hardstands and the tracks providing access to these.

Cable trenching around the site continues, with completion again prioritised according to the turbine delivery and erection programme. The cables transport the electricity from the different turbine arrays back to the wind farm substation at Upper Kergord. Visual anomalies were noticed in a relatively small proportion of the early cable deliveries to site. At the time of writing, contractual discussions on these are ongoing, but are heading towards conclusion. The vast majority of cables and cabling on the site are not affected by this query, and there has been no impact on Vestas' mobilisation process for turbine erection or to the overall critical path/timescale for completing the wind farm in 2024.

Once cable work in the different turbine arrays completes, then this allows ongoing track and crane hardstand surface capping to be completed; verge reinstatement/landscaping to be completed; and installation of permanent drainage around the site to continue.

Borrow Pits

Whilst the site is being finished off, there will be an ongoing requirement for processed rock and aggregates in all geographical segments, related to cabling, capping, verge reinstatement and permanent drainage. There will be a phased closure and reinstatement of all the borrow pits. RJ McLeod will be responsible for submitting individual borrow pit reinstatement plans to the SIC for consideration as the Local Planning Authority. The first borrow pit to be closed, capped off and reinstated is expected to be KBP02 in the northwest of the overall site.

Great Progress

All working on VEFW are proud of reaching the various milestones highlighted above. We look forward to seeing the first turbines completed and to remaining on track and on budget to project completion in 2024, delivering a central pillar of Shetland's energy transition and pathway to achieving net zero.

Substation progress

Viking Substation

The Viking Substation is located on the northern end of the platform at Upper Kergord, and all of the ca 1800 million units of electricity to be generated across the 103 turbines of the VEFW site will be routed through it. Civil construction works are nearing completion and should be finished by early summer. The buildings are structurally complete, and the focus is now on the mechanical, electrical and data fit-out works, and overall commissioning and testing of all the installed equipment.

The commissioning phase of the Substation works involves inspection, testing, energisation and operation of the plant/equipment i.e., switchgear, isolation equipment, control equipment, protection equipment and measurement of the various panels and equipment.

The high voltage (HV) cabling from the wind turbines, which comprises 16 arrays, is being routed from all the different segments of the wind farm back to Upper Kergord via a network of cable trenches. These cable arrays are installed up to the 33kV side of Substation and terminate at the internal switchgear panels. The switchgear has 33 bays with each one managing termination, isolation and control of the circuits.

A switchgear assembly has two types of components:

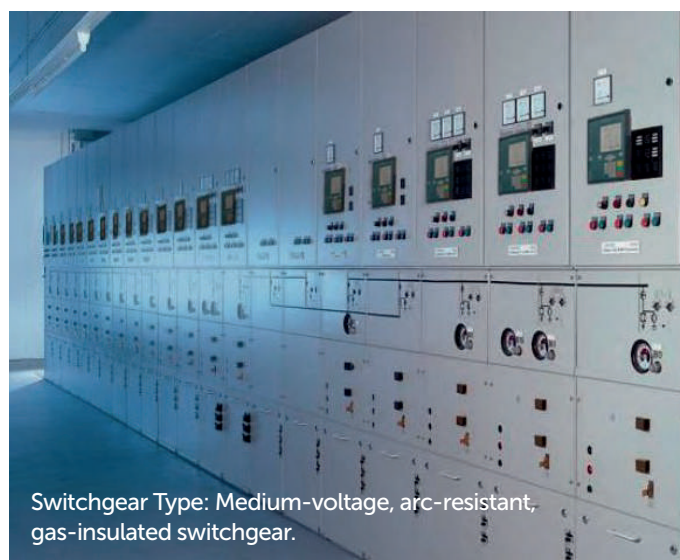
1. Power-conducting components, such as switches, circuit breakers, fuses, and lightning arrestors, that conduct or interrupt the flow of electrical power.
2. Control systems such as control panels, current transformers, potential transformers, protective relays, and associated circuitry, that monitor, control, and protect the power-conducting components.

From the switchgear the high voltage cables will then run to each of the four grid transformer halls and terminate at the 33kV side of the grid transformers.



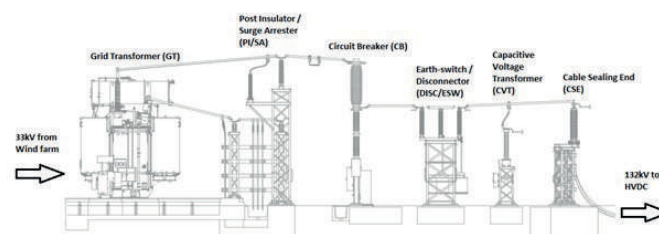
The grid transformers will then step-up the voltage from 33kV to 132kV. From there the power will be transported via the busbars which implement the control, isolation and measurement equipment – i.e.

- Post Insulator (PI) / Surge Arrester (SA) – insulates and protects the electrical plant



Switchgear Type: Medium-voltage, arc-resistant, gas-insulated switchgear.

- Circuit breaker (CB) – protects electrical circuit from overcurrent / short circuit
- Earth-switch / Disconnecter (DISC/ESW) – mechanical earthing switch
- Capacitive Voltage Transformer (CVT) – provides measurable values for metering
- Cable Sealing End (CSE) – cable joint/termination point.



From the cable sealing ends the cables will run on to SSE Networks' HVDC plant.

Indicative dates:

- Initial works started in August 2021.
- Building foundation works started in September 2021.
- Switchgear building steelwork started in November 2021.
- Grid transformer hall steelwork commenced in December 2021.
- Grid transformer halls – electrical equipment installation started April 2022.
- External wall / cladding was completed for all buildings in August 2022.
- Switchgear equipment was delivered on site by August 2022.
- Switchgear commissioning started in September 2022.
- Overall substation completion is expected by early summer 2023.



An example of chelate sediment on a stone from the upper reaches of Lunklet Burn's catchment. Overall fish populations remain intact in the wider catchment network, despite reports to the contrary.

Burn of Lunklet – Recent Issues Explained

As part of its development conditions, Viking Energy Wind Farm (VEWF) is required to carry out an extensive programme of water quality monitoring which has been a subject in these newsletters in the past. The Water Quality Management Plan (WQMP), required as part of these conditions, sets out the requirement for VEWF to make water quality reports available to Shetland Islands Council (SIC) and SEPA. These have been issued throughout the project and will continue to be submitted. The SIC uploads these reports to their online portal making them open to public scrutiny.

The project is often contacted following release of these reports for comment by various media bodies, local politicians and residents, some representing interested organisations. Very full and detailed responses have been issued to all queries; however, these responses are sometimes only partly or selectively reported, and some important detail and context is often missed as a result, sometimes in favour of dramatic headlines.

VEWF would like to take this opportunity to outline, in more depth, the cause and impact of issues at the Burn of Lunklet and to reassure the public of mitigation measures already instigated. VEWF accepts that the issues presenting in the upper reaches of the Burn of Lunklet are a direct result of the development, but they have not

been ignored or treated lightly and we have sought to be transparent and open with interested parties at all times.

The WQMP is extensive and includes twenty-five locations in eighteen separate burns sampled monthly and compared against baseline data compiled prior to the development starting. Field testing is carried out for measurable parameters and followed up with detailed analysis through the University of Highlands and Islands' UKAS accredited lab. Sampling also takes place quarterly at twenty-two locations around ten separate lochs and is subjected to the same extensive lab testing.

The Burn of Lunklet

Peaty burns have a tendency to be of low pH (i.e., slightly acidic due to the presence of peat) and as such the Burn of Lunklet naturally has a pH averaging around pH6.5, but has been noted as low as pH5.2 prior to any works starting in the area. The Burn of Lunklet is fed from various tributaries and from the Loch of Lunklet. One tributary, known locally as Red Burn, has its headwaters in a catchment west of the hill of Scallafield near to where the project has been excavating a borrow pit (KBP02) to gain stone for use in construction. It is speculated that the Red Burn gets its name due to iron precipitation, the reddish rust look you sometimes see exuding from peat.

There is an area of the lower reach of the Burn of Lunklet that is designated as a Site of Special Scientific Interest (SSSI). It should be noted that this designation is made due to a species of hawkweed noted on the banks of the burn. The burn itself does not carry SSSI status.

Borrow Pit KBP02

The development of a borrow pit requires the stripping of peat, which is saved for reinstating it when works are complete. This peat mantle provides a barrier between the rock surface and the atmosphere so creating an anaerobic zone on the rock surface. Once stripped, and exposed to the atmosphere and water, the rock can oxidise and hydro-chemical processes can occur that release metallic oxides such as iron ("rust" and hydrogen ions). In some cases, particularly where sulphide bearing minerals are present, this can lead to reactions lowering water pH. The underlying geology around Scallafield is very mixed and the location of these sulphide bearing mineral seams is unpredictable.

Hydrochemistry

The release of metals from rock seams through the migration of water is a natural occurrence, similar to some bottled waters promoting the inclusion of essential metallic minerals in their product. However, it is the type and nature of the chemicals that determine what may be detrimental to a watercourse and what is not. If more acidic conditions exist such that the metals change to a dissolved state within the water, then this can be detrimental to aquatic organisms.

Each metal will change its form under specific hydro-chemical conditions, and it has been noted by the water quality monitoring that manganese, iron, aluminium, nickel and zinc concentrations in the dissolved and bioavailable state have been mobilised in the Burn

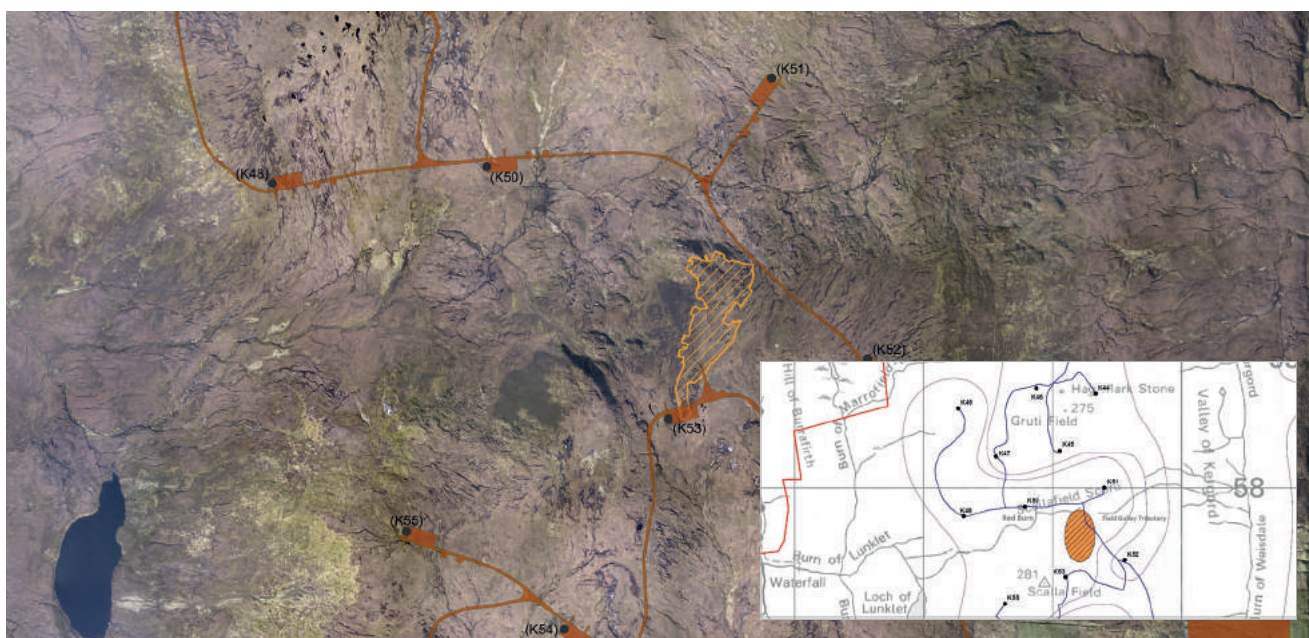
of Lunklet and have exceeded environmental quality standards, primarily due to the drop in water pH.

Impacts on Fish and Invertebrates

Once these metallic compounds are in a dissolved state they can further react with various naturally present organic compounds in the water and form organo-metallic structures (chelates) which precipitate out as sediments on the gravel and rock bed of the burns. An example of this naturally occurring reaction would be the reddish/rusty deposits sometimes seen on the rocks in peaty burns and ditches.

In the case of the Burn of Lunklet, these chelates have presented themselves as a coating on the gravels and stones in some stretches of the burn. This coating has resulted in making conditions inhospitable to the invertebrate population and similarly less attractive to spawning fish. As you might appreciate, there are many parameters and conditions required in a flowing burn for this precipitation reaction to occur, so the locations where this precipitation occurs are not fully widespread and some areas of the Burn of Lunklet are not affected at all. Hence the fish population survey has shown an affected stretch of the Burn of Lunklet to be devoid of juvenile fish, but the overall fish populations remain intact, albeit in other locations within the wider catchment network. It is possible that in due course the areas devoid of fish could be repopulated from unaffected tributaries and stretches, once conditions improve.

As well as being fed from the Red Burn, the Burn of Lunklet is also fed from an outfall of the Loch of Lunklet. The stretch of the Burn of Lunklet from the loch to the confluence with the Red Burn is unaffected by these conditions and fish continue to exist there at similar



Map showing location of KBP02, Red Burn and other parts of the Burn of Lunklet's catchment.

levels noted in the pre-works surveys. Similarly, on its course west, the Burn of Marrofield feeds into the Burn of Lunklet upstream of the picturesque waterfall. The Burn of Marrofield is also not affected by these conditions. Fish do not travel up the waterfall (with the possible exception of European eel) and it is noted that a population of fish remains downstream of the waterfall. So, to say that the Burn of Lunklet is barren of fish, as was the case in recent headlines, was unfortunate and factually incorrect.

Remedial Works

Despite some accusations to the contrary, it is never the deliberate intention of the project to cause any unnecessary environmental impact. Throughout the project, design measures have been applied to minimize and/or offset the development's impact on the natural environment. This issue at Burn of Lunklet however is an unplanned event, and the project takes this incident very seriously. SEPA were informed when it became apparent that conditions were not an isolated spike in the data and continued to present themselves. The project remains in consultation with SEPA, keeping them abreast of the measures being taken to resolve the situation.

Key to the remediation strategy is to prevent these detrimental hydro-chemical reactions and allow the catchment to return to its natural equilibrium. Therefore, suppressing the oxidation process is viewed as the overarching remedial measure. Around 80% of the borrow pit is currently capped with stored peat, and the offending section of exposed rock is currently being prepared for infill and will be permanently capped with a mantle of peat, so preventing the rock from being exposed to oxygen.

In addition, the project has introduced limestone rock to the outlets from the borrow pit, as calcium carbonate has the effect of neutralising these acidic conditions. With rock this had a limited impact, but an alternative source of softer calcium carbonate has been identified and is being trialled at present, with more positive indications of success. Further discussions will be held with SEPA on the practicality of using this source, should it continue to be successful, and, if approved, efforts will be scaled-up to accelerate the reversal of the low pH conditions, in conjunction with the surface capping activities in the borrow pit.

Burn of Weisdale

It would be remiss not mention the Burn of Weisdale at this point. The Burn of Weisdale receives run-off from the eastern side of Scallafield and is not naturally affected by surface run off from the borrow pit. However, recently we observed some similar precipitate conditions in a tributary which originates from the top of Scallafield and flows to the Burn of Weisdale. Having carried out an extensive survey and field testing of this pathway, the project has identified that drainage from the infrastructure in and



Chelate sediment on pebbles in the Burn of Lunklet catchment. Remedial measures are now well underway.

around the borrow pit has channeled its way to an outlet from a turbine hard standing to the east of the summit of Scallafield. The tracks and crane hard standings in this area are currently being capped to help to guard against oxidation of the rock used to construct them, and the same pH neutralising trials are ongoing at the surface outlet of this water pathway. We believe that we now better understand the water system feeding the Burn of Weisdale and are taking active steps to arrest this matter before there are any significant impacts on it.

Return to Equilibrium and Ongoing Monitoring

Monitoring, including additional monitoring points, will continue to evaluate the effectiveness of the different mitigation measures. The invertebrate and fish populations will also continue to be monitored, including assessments of the areas where the organo-metallic sediments have occurred. As these sediments have not had the chance to become embedded, it is expected that, post borrow pit capping and pH treatment, heavy periods of rain will flush through the gravel bed and rocks. With low concentrations of sediments and high dilution, the dispersal of the sediments is predicted to have a negligible impact further downstream. If it appears that conditions are not naturally returning to the previous equilibrium, then the project will investigate more intrusive measures to ensure the material is removed.

The project is conditioned to continue with the quality monitoring programme for 12 months after the commissioning of the wind farm and these issues will remain at the forefront of that programme. Should additional intervention works be required, then these will be carried out.

Shetland Community Benefit Fund



South Mainland Up Helly Aa.



Burra Kirk, Shetland Carers. From left Karen Fraser manager, Lyndsay McLaughlan Admin Assistant and Eillen Mowat Deputy Manager.



Shetland Youth Orchestra.

This year has got off to a good start with 12 applications received in January. For tier 1, examples of applications received are: a parent and toddler group to purchase new toys; sporting groups to purchase equipment and travel to events; along with a local charity which is hoping to create community raised beds for growing fresh vegetables. Two tier 2 applications include: costs of a residential school trip outside Shetland; and the repurposing of some unused land into a nature garden with raised beds and clubhouse improvements. Recent applications also include supporting the newly formed Shetland Youth Orchestra and a marina improvement project. In total since its launch two years ago, there have been 380 applications received to the fund to a value of £672,142.

What's happening in 2023

As we head into a new phase of building the Viking Energy Wind Farm, it's great to be putting things in place where we get a chance to be out and about in the community. We have started off the year by directly supporting a range of local projects including the amazing



James Leask, Up Helly Aa Treasurer. In his daytime job, James works for Petersons, including management of VEVF/Vestas shipments unloading at the Greehead Base in Lerwick.

charity Shetland Heart Screening, that was set up to help spot undiagnosed heart conditions in young people. It was also super to see so many people out celebrating the fire festivals once again taking place all over Shetland. A big thank you to the Lerwick Up Helly Aa Committee who invited us to visit the Galley Shed where James Leask provided a conducted tour.

We are also fortunate to now be supporting the Shetland Hockey Team as they have once again kicked off the season in great style with a 3-0 win against Livingston and West Lothian. We are again also supporting Shetland Netball, Parish Cup and Lerwick Rangers FC.

Our support of CLAN's 40th Anniversary fundraiser – The Big Hop is now well underway with the design for our hare chosen and we all eagerly await its arrival. A smaller hare will be continuing its journey to Baltasound School where it will be



Gerard Hamill of VEVF presenting a cheque to the Pirie family representing Shetland Heart Screening.

the most northerly hare in the CLAN sculpture trail.

It was fantastic news last year that Lerwick was chosen as a host port for the Tall Ships race. SSE Renewables is a host port sponsor, and we are all looking forward to taking part in this amazing event in July.

STEM Update

After the success of last years' 3DW build a virtual windfarm workshops, we are running them again. Students from Baltasound and Mid Yell schools will be attending UHI in Lerwick in May with Anderson High taking part in September 2023 and March 2024.

We will be attending the SCDI Shetland celebration of STEM with our colleagues from SSEN Transmission. This will be taking place on June 21st at Shetland Museum and Archives, where local schools will compete in a Pylon Challenge. There will be numerous other STEM related activities taking place during this exciting event.

Vaila's windy day update



Whalsay Primary School



Fair Isle Primary School



Sandness Primary School

Last year we successfully rolled out a virtual teaching resource to all the primary schools in Shetland. This was very well received and in total 85 primary schools, 2 secondary schools, 10 home schoolers and 9 youth groups in the UK have registered to use Vaila's Windy day. There has been a total of 310 downloads, 97 of which were in Shetland. This exciting and engaging resource is still available for parents, schools and groups.

<https://nationalschoolpartnership.com/initiatives/vailas-windy-day/>

A competition to draw weather and renewable energy related pictures, open to all Shetland schools, closed in December and was judged a few weeks later. Winning entries won an anemometer for their school and these have been sent out as far as Fair Isle.

Annette Gear teacher at Mid Yell JHS said: "The anemometers arrived safely, and the bairns were very excited. We have been trying to measure and record the weather, and these digital meters are much easier to work with than the ones we had. Thank you so much!"



Apprentices getting ready to work at VEFW

Apprenticeships have a big part to play in allowing businesses and people unlock potential. They connect people with ambition, from diverse backgrounds, with a wide range of abilities, to businesses with the vision to see their potential.

VEFW staff recently had the great pleasure of spending a day with Anna McDowall at an Apprenticeship and Local Opportunity Event run by DYW in Lerwick. This 17-year-old is mature beyond her years and a

great ambassador for Shetland, for apprenticeships and the renewable industry as a whole. It was a busy day and Anna spoke about her time as an apprentice with confidence, passion and knowledge.

She left Shetland to start her NC in Electrical and Mechanical Engineering at Inverness College at just 16 years old – her first time away from home. Now in her second year, Anna is undertaking an HNC in Electrical Engineering at North East Scotland College in Fraserburgh.



The first tower section being erected in North Nesting. A picture of the second section being added can be seen on page 4. The first fully completed turbines should start to appear during April.

How do you build a wind turbine?

With wind turbine component deliveries well underway, the team at the Viking Wind Farm are excited to welcome the next phase of the project as we start to construct the wind turbines from the individual components. So, how do you build a wind turbine?

Safety is the most important consideration throughout the construction phase, and putting the turbines up is no different. The process of building the Viking wind turbines involves using heavy cranes to lift components, some with a combined weight heavier than 100 tonnes, to a height of almost 100 m in the air. Here they are lifted on top of another component and then bolted into place. To do this safely, each crane lift is carefully planned, risk assessed, supervised and executed by specialist teams. The work is also planned to do as much as possible on the ground (in terms of preparing the components) so we minimize the amount of working at height. To be able to operate the cranes safely, the civil engineering design of the wind farm includes a specialist crane pad, built adjacent to every turbine foundation for the crane to set up on. This pad has to be suitably flat and be able to withstand the many tonnes of downward pressure that the cranes apply to the ground when doing the lifts.

The first part of the wind turbine to be erected is the tower. The towers of the Viking wind turbines are transported to the site as four separate tubular steel sections. A crane we refer to as the “pre-assembly crane” first lifts the base tower onto the foundation and the installation team bolt the tower to the foundation. Once secured, the pre-assembly crane then lifts the second tower section on top of the base tower. There are fixed ladders and platforms within the tower sections that allow the installation team to then ascend the inside of the base tower and bolt the two tower sections together. This complete operation we refer to as pre-assembly.

At this point we need to lift the remaining components even higher, so a different, even bigger, crane is deployed to the wind turbine location. This is referred to as the “main crane”. The main crane then lifts the last remaining two tower sections into place (one at a time), in a similar manner to the pre-assembly crane.

The next step is to install the nacelle and drivetrain on top of the tower. The nacelle is the box-like structure that sits on top of the tower and houses the drive train and the power generation equipment. Once the nacelle and drivetrain are installed, the main crane then lifts the hub into place in front of the nacelle. The hub is the central bit of the rotor at the front of the turbine that the blades connect into.

The final part of the main installation is the blades. The blades at each wind turbine will be lifted into place one-at-a-time. Firstly, the hub is prepared and securely positioned ready to receive a blade. A specialised “blade gripper” attachment is attached to the crane and used to clamp onto the blade at the blade’s center of gravity. The blade is then lifted upwards with the blade itself staying in a horizontal position. A combination of long tag lines attached to the ends of the blades and a remote-control fan system (attached between the blade gripper and the crane hook) allows the installation team to control the rotation of the blade as it is lifted. The precision crane operation will then lift the blade in that horizontal position so it can dock with the hub. The installation team then climb into the hub and bolt the blade into position. Once the blade is installed, the installation team retreat back to the nacelle, and the hub and blade are rotated 120°, using a motor, to allow the second blade to be installed. The hub is re-secured in position and the operation is repeated a further two times to install the remaining two blades. Once all three blades are secured, the structure is fully in place and the main installation of that wind turbine is complete.

All you want to know about turbine foundations

The construction of reinforced concrete foundations for wind turbines requires a series of civil engineering works, to ensure that the foundations are structurally sound and can withstand the extreme forces exerted by the turbines during operation. The process includes excavation, the installation of a reinforcing cage, shuttering and pouring the concrete, curing, and preparing the foundation for the installation of the turbine tower and blades. A well-designed, reinforced concrete foundation is essential to ensure the safe and reliable operation of a wind turbine, and careful attention must be paid to every step in the construction process, to ensure that the foundation meets the required standards for strength and stability. It must be designed to support the weight of the turbine and withstand the forces generated by the wind over the course of the lifetime of the wind farm. For this reason, the foundations have to serve as large scale underground support structures.



Turbine foundation shuttered and concrete poured.

Viking Energy Wind Farm started this construction journey on 6th September 2022, with the commencement of the first base pour, and on 12th November 2022, we completed the construction of all 103 bases.

Each base was composed of 682m³ of concrete and 105 tonnes of steel. In total for 103 bases, the totals are therefore 70,246m³ and 10,815 tonnes respectively. It took 412 trailer loads of deliveries on the ferry to Shetland to get the materials required from the mainland that were not readily available in Shetland. Wherever possible though, the project looked to utilize the materials, available plant and workforce to carry out the works from local sources, to retain value and benefit the local economy. The spend on foundations is part of a wider direct spend with the local supply chain of around £53m, which is growing every day.



Backfill foundation with selected graded stone up to top of concrete.

Summary of facts at a glance...

- 103 foundations with 682m³ of concrete in each is 70,246m³ in total.
- 105 tonnes of steel rebar are used in each pour, total of 10,815 tonnes. 412 trailer loads delivered via ferry to Shetland.
- 208nr bolts per foundation, 103 turbines – 21,424 in total.
- 292 tonnes of cement used per foundation (including turret), 30,076 tonnes in total, 1,037 tanker loads of cement brought to site via the ferry after collection in Aberdeen.
- 107,000 litres of water used per base. 11,000,000 litres of water in total used for the bases.
- 719 tonnes of aggregates used per foundation, 74,057 tonnes in total.
- 564 tonnes of sand used per foundation, 58,092 tonnes in total. Imported from Glensanda (which is also an area settled by the Vikings!) via boat to Lerwick Port. 10 boat loads in total taken to Shetland.
- 5,768m³ used for blinding's imported from local concrete suppliers, EMN, Garriock Bros and Tullochs.
- Every mixer truck in Shetland supplemented RJ McLeod and hired-in trucks!
- 2 locally hired cranes were on permanent hire for more than a year to help build the reinforcing.
- 32 people were involved on average in each pour, including a broken site agent and a broken general foreman by the end of it!
- First pour 06/09/22, last pour 12/11/22.

The stages: from pouring concrete to handing over...

1. **Concrete Pouring:** Once the foundation has been excavated, reinforced, and prepared, the next step is to pour the concrete. This is typically done using a pump truck that pours the concrete into the excavation in layers. The concrete must be carefully placed and vibrated to ensure it fills all the gaps and fully encapsulates the rebar.
2. **Curing:** After the concrete is poured, it must be allowed to cure for a period of time before any further work can be done on the foundation. The curing process is critical to ensure the concrete reaches its full strength and durability. The duration of curing varies depending on the specific concrete mix used, but typically takes several days.
3. **Grouting:** Once the concrete has cured, the next step is to fill any voids or gaps between the foundation and the tower base with grout. This helps to create a uniform load transfer between the tower base and the foundation, which is important for the overall stability of the turbine.
4. **Anchor bolt installation:** Anchor bolts are used to secure the tower base to the foundation. They are typically embedded in the concrete during the pouring process, but the final tightening and torquing of the bolts must be done at the final stages. This is critical to ensure that the tower is securely attached to the foundation.
5. **Site clean-up:** Finally, once all the civil engineering works have been completed, the site must be cleaned up. This includes removing any construction debris, equipment, and tools from the area. The site should be left in a safe and tidy condition.



Delivery of hub, nacelle, drive train, base tower and lower mid tower.



Construct "blade fingers" and two auxiliary hardstands.



Backfill cable trenches allowing final capping and landscaping ahead of component deliveries.

These are some of the critical civil engineering works that happen at the final stages of completing foundations for a wind turbine base. Each step is important to ensure the safety, stability, and durability of the foundation and the turbine.

Some final points:

1. **Completion of foundation work:** Once the turbine foundations are poured and cured, the construction team will complete the final foundation work. This includes backfilling around the foundation and compacting.
2. **Installation of underground cables:** The underground cables that will connect the turbines to the substation need to be installed. This includes trenching, laying the cables, and backfilling.
3. **Construction of access roads:** Access roads needed to be built to allow the bases to be prepared and for the turbines to be transported to the site and installed. The construction teams created 70km of service roads and lay down hard standings for cranes and other heavy equipment.

Kergord HVDC update

Following a well-deserved Christmas break works recommenced on the HVDC Converter Station at Kergord in early January and 2023 brings us into our third calendar year since breaking ground on the project. Since arriving back, external civils works have been progressing well including fencing and footpaths, as well as mechanical and electrical items such as lighting and CCTV works.

The works remain on programme and the Civil Contractor (BAM) is focusing on the completion of the remaining civil works, including final commissioning of the Mechanical and Electrical systems. Once the weather improves and we enter drier months BAM will look to commence works on the permanent watercourses and landscaping works.

BAM is continuing to work collaboratively with Hitachi Energy to ensure the installation of HVDC equipment and remaining cabling will be completed on time. Other works ongoing between BAM and Hitachi Energy include the completion of the main earthing systems for the station. This work will enable the Distribution Network Operator (DNO) supply to be energised. The DNO power supply will be used during Commissioning to test all the newly installed systems within the HVDC station, this work will enable the DNO power supply to be energised by summer 2023. The DNO, once operational, becomes the backup supply to the HVDC converter station with the main power supply for the building coming from the HVDC converter itself.



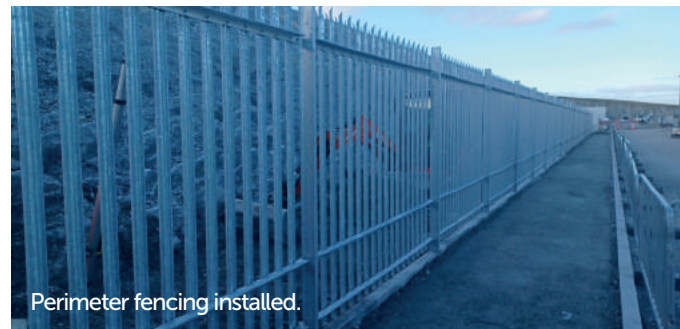
Drone footage taken by Shetland Flyer of the Kergord HVDC Station.

Lookahead:

- Service Building snagging works.
- External civils completion, including completion of fencing.
- Final mechanical and electrical testing and commissioning.
- Preparation works for DNO permanent power switchover.



Concrete footpaths being installed around perimeter of Converter Building.



Perimeter fencing installed.



Drone footage taken by Shetland Flyer of the Kergord HVDC Station.



Typical examples of protection & control relay panels for a 132kV circuit.

AC Substation update

The 132kV Substation has seen a lot of progress since returning from the festive break, with external works substantially complete (awaiting the final surfacing course) and a significant amount of wiring works ongoing within the building Protection & Control Panels. There have been approximately 920 cables, each of which contain multiple cores, resulting in approximately 11,000 single cores being individually connected into the panels.

The GIS (Gas Insulated Switchgear) has now been fully assembled with all GIS Bays installed. The GIS Bays are the individual circuits from Power Generators such as the Viking Windfarm, where their 132kV cables terminate into the GIS. The power generated from the Viking Windfarm will be transported to the GIS through their 132kV cable circuit and the clean air GIS will then distribute this power across to the HVDC Converter Station.



Commissioning

We are now entering the early commissioning stage (stage 1) on site where we will be testing the interface between the GIS Switchgear through to the relay panels pictured. It is essential for our commissioning team to prove the integrity of these systems prior to the later energisation stage (stage 2).

This is a critical part for the delivery of the project as this equipment controls, protects and communicates back to the main SSEN control room based in Perth. This testing will ensure we can run the Substation and energy power flow as safely and efficiently as possible when we go into service.



Noss Head update

The Noss Head Switching Station is currently nearing the end of its commissioning phase and our contractor (Hitachi Energy) is working closely with the SSENT (SSEN Transmission) Commissioning & Operations team to ensure the Switching Station is ready for energisation in April 2023. The existing Caithness/Moray HVDC Cable was isolated during a planned outage and the cable was cut on the 23rd of January and the works to connect the Switching Station to the existing cable is now complete.

Lookahead:

- Energisation and Switching Station in service April 2023.
- Construction site reinstatement (temporary office removal, car park removal, lay down area removal, haul road removal) which will enable the site to be returned to the landowner.



Light guide fibre cable installations

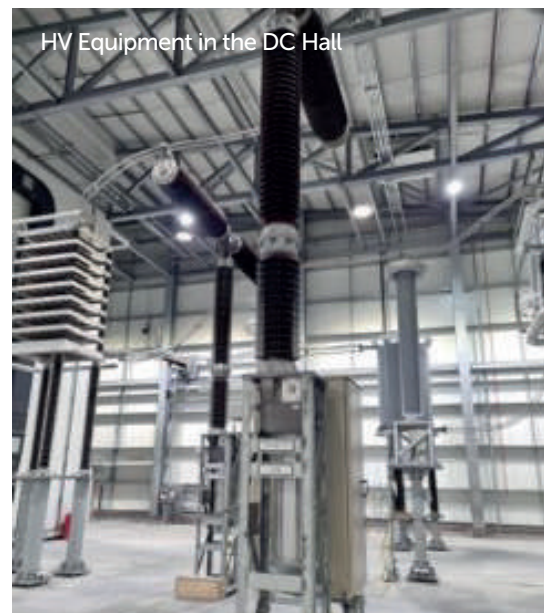


Hitachi Energy update

The HVDC Converter Station at Kergord was recently visited by Hitachi Energy's Global Head of Projects, for key engagements with senior management teams of SSENT and the projects technology contractor. The visit included a walkover of the completed high voltage installation and key workshops for the upcoming commissioning activities.

Hitachi Energy have now completed the installation of the light guide fibre cables and containment, which provide high speed communication between the main panel and control valves that allow the AC to DC conversion.

They have now commenced equipment testing ahead of the commissioning team's arrival in April, following on from energisation at the Noss Head Switching Station.



HV Equipment in the DC Hall

Look ahead:

The HVDC Station will be energised directly from the Distribution Network Operator (DNO) power supply, allowing the station supplies to be commissioned. This will then enable the Quality and Commissioning teams to progress the technology package further over the coming months.



Landfall works at Weisdale Voe.

Cable Installation Works

All HVDC cable manufacturing for the project has now been successfully completed in March 2023. The Shetland HVDC Project Team have now completed Campaign 1 and fully installed and protected the first 100km of cable, from Caithness, heading up to Shetland.

Pre-Lay Grapnel Run (PLGR) for Campaigns 2 & 3 took place in February 2023, as scheduled. This ensures that the route is clear of debris, prior to cable lay and was carried out by the MV Sima, which demobilised on the 28th of February in Denmark.

In Shetland, the duct installation at Weisdale Voe is now complete, in advance of the cable pull-in. This involved stringent adherence to environmental requirements in the local areas, such as silt management, local mammal observations, (footprints in the mud have confirmed that we haven't upset the local otter family!), as well as maintaining communication with the local Community and Stakeholders.

The duct installation was required to support the cable pull-in, successfully took place in mid March. The NKT Victoria sailed from Sweden on the 13th of March arriving in the Voe later that week to complete the cable



Otters footprints spotted at the Weisdale Voe landfall works.



NKT Victoria Cable Laying Vessel (CLV).

pull in. Good co-ordination and communication from the many parties involved, both onshore and offshore, has, once again, resulted in a successful pull-in for the Shetland HVDC project. The Victoria then went on to lay the rest of the cable for Campaign 2.

This is a major milestone for the project as this now means Shetland is a step closer to being connected to the GB Transmission system for the first time, with the 3rd and final campaign on schedule for execution in the Summer of 2023.

Lookahead:

- Trenching using the Grand Canyon III will follow on from cable lay.
- Local diving works after the pull-in to install the cable protection system, scheduled for March/April.
- April/May will see shallow water trenching take place, this involves an Aberdeenshire based company performing automated works in the shallow area of the Voe that the Grand Canyon III is unable to access to assist with burial of the cable.
- Aiming to complete our fibre optic cable installation works in late May, this will involve road works and associated traffic management on the A971.

Otter activity at Weisdale Voe

We recently caught up with NKT's Environmental Clerk of Works (ECoW), Andrew Whitelee, who has provided an insight into the otters he has been monitoring down at Weisdale Voe.

"Shetland is famous for its otters, with an estimated population of 800 to 1000 living across the island group, the highest density of otters anywhere in Europe. The otters of Shetland have been isolated from other populations for so long, that they are now genetically slightly different. The Shetland otters tend to be slightly smaller than in the rest of Europe and have a characteristic light markings under their chins.

"Otters are usually nocturnal hunters but the Shetland otters can often be seen out during the day time with their routines more closely linked to tide times than daylight hours. The area around landfall, where the ducting works have been taking place is known to have otters present. Prior to works beginning, otter surveys were carried out to identify and locate any holts or places of rest where otters were present. The project environmental team then created an Otter Species Protection Plan which described how we would work in order to minimise disturbance to the local otters. This Species Protection Plan was submitted to Nature Scot along with a licence application so that the works could continue.

"Since the beginning of the project, the project ecologist has been monitoring the movements of otters along



the foreshore area of Weisdale Voe. This was done by a combination of surveys and the use of trail cameras. "Prior to the ducting works, every site operative was given a toolbox talk on otters and reminded to check their plant and machinery in the morning before work commenced. Otters can be inquisitive creatures and it is not unusual for them to visit construction sites during the night, and even to curl up for a quick nap under an excavator. Throughout the works, the project ecologist was present to look for otters and to instruct works to stop if the otter came too close to works. Otters were seen swimming in the Voe on several occasions during the works and were even noted checking out the silt curtains installed in the water. Both physical observations and trail camera footage show that the otters were unperturbed by our presence, and have gone about their business as usual, which is a big success for the project."



Photos taken by Andrew Whitelee.

Shetland Renewable Connections update

Gremista Grid Supply Point (GSP)

SHEPD are progressing well with the earthworks and platform formation for the new Substation at Gremista and remains on track to complete a handover to SSEN Transmission in July.

Our contractors, Norpower (Overhead Lines) and OMSI (Underground cabling and Substation works) are continuing to carry out site visits to conduct surveys in preparation for the start of construction works.

Cul Ness to Yell

A marine survey is scheduled for late spring between Cul Ness and Yell, this Geophysical and Geotechnical survey will provide critical data for the proposed subsea cable route which will link Kergord HVDC Station to Yell.



Ground Engineering Awards

Since our last newsletter, the Ground Investigation campaign that was carried out in Burravoe last year by BakerHicks and BAM Ritchie has been submitted to the Ground Engineering Awards. The finalists will be announced this month, with the winner being announced on the 12th of July.

The project has been exciting and challenging with multiple considerations taken into account. It is a true testament of team work between client, designer and contractor, with considerable input from the various subcontracted specialists and the knowledge and expertise of local subcontractors.

Helicopter Flights Scheduled

Kergord to Cul Ness route – site survey

Norpower successfully carried out a helicopter flyover this month, flying from Kergord to Cul Ness to plan out the future overhead line route that will connect the Kergord HVDC converter station to Yell.

Gremista to Kergord route - material transportation

Looking ahead to early May, Norpower will commence transportation of wooden poles and steelwork by helicopter from Lerwick to four different lay down areas in Tingwall and Girdsta. Exact dates of these operations will be released in the media nearer the time.



Archaeology Survey

In February, ORCA Archaeology completed a walkover survey of the proposed 132kV underground cable route from the new Gremista Grid Supply Point (GSP) to the Kergord Substation, on behalf of SSEN Transmission.

The survey was undertaken to identify and assess sites of cultural heritage significance along the proposed route. The team encountered a range of sites spanning over 4000 years of Shetland's history, from a Bronze

Age burnt mound to post-Medieval farmsteads. ORCA and SSEN Transmission will be consulting with the Shetland Regional Archaeologist to ensure that the underground cable works avoid impact on the historic environment.

SSEN Transmission's appointed cabling contractor (OMSI) will also use this information to inform archaeological mitigation measures for construction works.



Bronze Age burnt mound at Swinister - photo taken by ORCA.



Head dyke along the Hill of Herrislea - photo taken by ORCA.

Spotlight on: Local Opportunities and Apprenticeship Event

In February SSEN Transmission, SSE Renewables, SSEN Distribution and Vestas attended a Local Opportunities and Apprenticeship event in Lerwick, hosted by DYW Shetland and the Anderson High School. The purpose of the event was to bring together local businesses, organisations, education and training institutions that offer apprenticeships, courses, training and/or voluntary opportunities to young people in Shetland.

Thea Groat from SSEN Transmission said, "Students from Shetland High Schools, Shetland College UHI and parents were invited along to engage with local businesses, and it was excellent to see so many of them interested in the energy industry and our transition to Net Zero. It is a very exciting time for Shetland and SSEN Transmission, and this was the perfect chance to showcase the opportunities that are available as the Transmission business continues to grow".

Julie Graham from SSEN Renewables said, "The event attracted both parents and students and was a brilliant opportunity to speak to a great number of young people as they start to plan their future career paths. It was great to be able to showcase the opportunities with SSE Renewables and discuss the growing range of jobs available in the sector as we progress towards Net Zero. I would like to say a big thank you to DYW for inviting us along to this event."

A spokesperson for SSEN Distribution said, "We attended the event with our Trainee Engineer, Freya Laurenson and Multi Discipline Apprentice, Ross Fraser who had the opportunity to speak with students and give them an insight on what an apprenticeship with SSE entails. It was also an opportunity for us to encourage applicants for the two Craft Apprenticeships that we are advertising this year."

Meet The Team



We're shining the spotlight on team members working to help power change in Shetland. This month we caught up with Louiza Azzi

Name: Louiza Azzi

Job Title: NEC3 Civils Supervisor

Number of years working in your role: 1 year, 1 month

How did you get started in your career – what did you do before the SSEN Transmission Shetland HVDC Link project?

Before joining the SSEN Transmission Kergord team I was a civils and structural design engineer working in the rail department of a civil engineering consultancy.

What inspired you to get into engineering?

My interest grew in college when I read an article about a construction project in Abu Dhabi called Masdar City, which was to be the first carbon zero city to exist. My "Ambition in Civil Engineering" presentation when I first applied to university was inspired by this and I proposed a future city constructed to withstand the effects of future sea level rise and which would use hydro power and wind turbines to provide the city's energy requirements. I realised over time that the real challenge is retrofitting existing cities to make them more sustainable – something I am proud to now be playing a part in.

What qualifications do you need for your role?

I have a Master of Engineering in Civil and Environmental Engineering, although any Master's degree in a Civil Engineering related topic would likely be accepted.

Talk us through a brief typical day in your job:

My main role is to ensure that the quality of the substation civils construction works is upheld, so my day

typically focuses on carrying out inspections of ongoing and completed construction works, signing them off if they are acceptable, or notifying the Contractor of a defect if the work is not in accordance with the Works Information. I keep track of remedial works and ensure they are carried out to the standard that SSEN Transmission require for a safe and high quality building.

What is the best part of your role?

The best part has been seeing the construction of the substation in action and getting to be part of the friendly and highly skilled team helping deliver the project. It is incredible to think back to what the site looked like when I arrived to how it is now, and how much I have learned from this experience and from my colleagues.

What is your proudest achievement so far while working on the SSEN Transmission Shetland HVDC Link Project?

Being involved in this project! It's a great feeling to know that the work that I carry out daily is contributing to creating a more sustainable society.

How do you help power change?

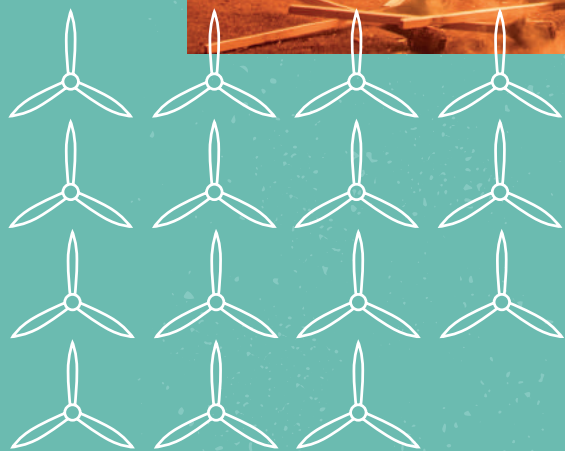
Being part of SSEN Transmission we are playing a crucial role in the transition to a low carbon future by delivering renewable energy to the National Grid and connecting Shetland to the National Grid for the first time.

Why is it important that we create a network for net zero?

Infrastructure is the key to unlocking net zero, and that places a responsibility on all industries, including the construction and energy industries, to actively create and implement sustainable solutions. With a goal of Net Zero set in the UK by 2050, these changes need to start now to be achievable.



Galley burning



To find out more about the projects and to register for updates please visit:
www.ssen-transmission.co.uk/projects/Shetland/
www.vikingenergy.co.uk/

