SÓLHEIMAR

Windfarm R4318A

ABSTRACT

The Sólheimar project is a 151.2 MW windfarm constructed in two phases. The project site is 3,200 hectars located in Laxárdalur in Dalasýsla. The project will be built in two phases due to the lack of connexion capacity to the national grid. Phase I constitutes 20 WTGs with an indicative installed power capacity of 112 MW and Phase II 7 WTGs with 39.2 MW. The project has been in ongoing since April 2018. Environmental Assessment study is well under way, a 100m meteorological mast has been on site since June 2019 and zoning is well under way. First research results indicate a very promising windfarm. In terms of efficiency the windfarm is categorized as Class 1 power plant.

27th of December 2019

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1 Introduction

1.1 Background

Iceland has an abundance of renewable energy sources due to the country's unique geographical and geological features. With over 99% of total electricity production in the country sourced from hydropower and geothermal energy, Iceland has become a global leader in sustainable energy production. Moreover, the country's energy production exceeds demand, creating opportunities for export and foreign investment to support the economic well-being of the Icelanders. Iceland now enjoys one of the highest per capita GDP in the World. This is to a great extent thanks to abundant sustainable energy produced in the country. However, to maintain continued increase in the standards of living alternative sources of energy must be harnessed, as hydro and geothermal opportunities present are limited compared to future needs and increased demand from the population for protection of Iceland's unique and vulnerable nature. Furthermore, the increasing necessity globally for less carbon-based energy sources has made demand for alternative sustainable sources of energy prodigious.

Little uptake of wind power technology has occurred in Iceland thus far due to its high costs when compared to geothermal and hydropower. However, as wind power technologies have advanced, harnessing wind power is an increasingly economical and competitive option for the country. The national power company, Landsvirkjun, has invested in small wind power research and development projects to further explore the possibilities of the country's wind energy production. Their research has shown that numerous areas in Iceland have highly favourable conditions for utilising wind resource and that most potential impacts wind power poses are not considered high in comparison to other types of power plants. Wind turbines can easily be dismantled. Thus, wind farms are not only renewable but fully reversible, i.e., after dismantling it leaves the land almost unspoiled compared to hydro plants with water dams and geothermal power plants.

Windfarms have been constructed both onshore and offshore in most countries. Whilst the technology employed is constantly changing generic project activities are well established and hence key issues and impacts are also generally well understood. Each project will also have its own set of unique impacts linked to the site-specific social and environmental setting within which the windfarm is to be constructed.

In selecting the Sólheimar site the Company took several constraints into consideration. Aside from necessary conditions, i.e., abundant wind, proximity to the grid and accessibility, the most important guidelines the company uses in selecting a wind park site is sufficient distance from places of natural and cultural importance, human dwellings (towns and farming communities) and tourist sites. It is the opinion of the Company that the Sólheimar site fulfils all these conditions. However, there is one caveat. The site sits in an area defined as important for wild birds. Consequently, great emphasis is put on understanding bird live in the area and to use best practice counter measures to minimize the impact on the bird population. For this latest technology will be used.

The Sólheimar wind farm will be developed in two phases. The first one is with 112 MW (20 WTGs) installed capacity and the second one 39.2 MW (7 WTGs). Power production in the first phase is assumed to be 461 GWh and additional 161 GWh in the second phase. A 100-meter-high metrological mast has been employed to study wind and general weather conditions at the site since mid-June 2019. An avifauna study has been ongoing since April 2019, an archaeological study has been conducted and a digital orographic model build. Numerus other technical and engineering studies have been carried out, among them is a micro-siting study based on data from various wind and weather data bases and topological, geographical and satellite information. An environmental study has been ongoing since early last summer and is planned to finalize next spring. The grid operator, Landsnet, has also conducted both a static and dynamic grid studies for the surrounding grid.

In undertaking preparation of the Sólheimar Project the Company draws upon:

- professional experience and specialist knowledge of potential impacts associated with the construction, operation and decommissioning of onshore windfarms Worldwide the last 25 years;
- international best practice guidance including the World Bank's EHS General Guidelines (2007), EHS Guidelines for Wind Energy (2015) and the EIA Guideline for the Energy Sector Volume I and II (2011);
- findings and observations from various research on the Project site, i.e., bird studies, archaeological studies, geo- and topological studies, flora and fauna studies; and
- relevant law and regulation in Iceland.

1.2 About Quadran Iceland Development

Quadran Iceland Development ehf. is an Icelandic subsidiary of Quadran International SAS, a French international IPP specialised in developing, financing, building and operating renewable energy generation facilities around the World. Quadran International has offices in 9 countries and is currently developing or building plants in 15 countries in Latin America, Eastern Europe, Northern Europe, Africa, and South-East Asia.

Quadran International has decided to extend its presence in Iceland and in order to push forward Quadran Iceland Development was established. The company's purpose is to develop, finance, own and operate wind farm projects in Iceland. Currently Quadran Iceland Development is developing a pipe of wind farm projects in Iceland.

Quadran International is a subsidiary of the Lucia Holding Group. Currently the Group is managing assets in three key sectors of renewable energy: wind, solar photovoltaic, and hydraulics. At the end of 2019, the Lucia Group was operating~~,~~ wind, hydro, and solar assets with a total installed capacity of 550 MW equating to total on-balance sheet assets in excess of EUR 1 billion.

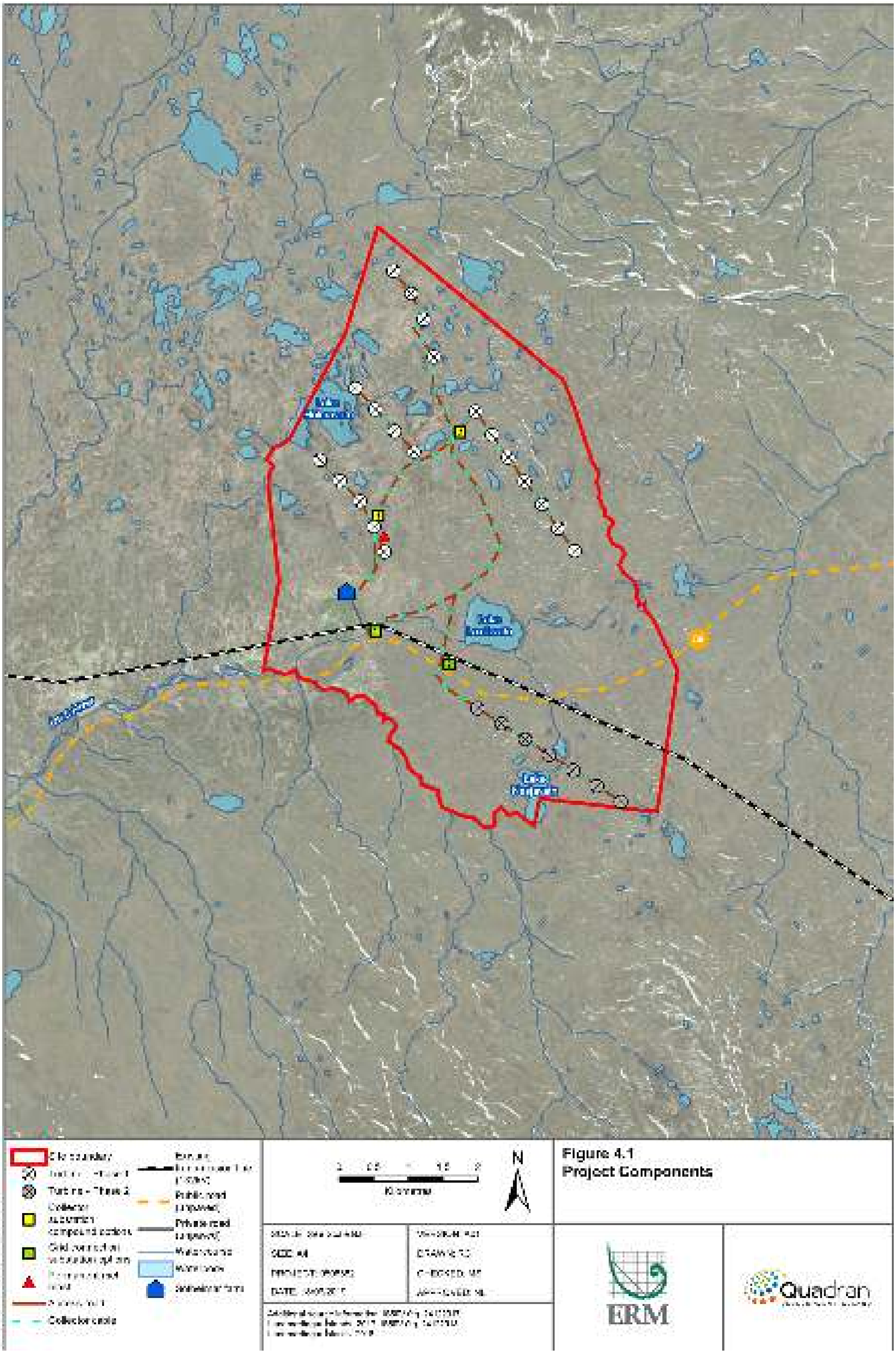
2 Project Description

2.1 Project Location

The 3,200 ha Project site is located on the eastern border of the municipality of Dalabyggð. The secondary, partly-paved road, Road 59, runs through the Project site for approximately 8 km and connects the two villages of Búðardalur and Borðeyri. There is a small farm on-site, and an unoccupied farm (i.e., summer house) 2.5 km away. The nearest village, Borðeyri, is approximately 10 km east of the site. The main community within the Project's municipality is Búðardalur, which lies about 23 km west of the site. The Project site location and extent is shown in Figure 1. The site boundary (in red) denotes the parcel of land that the Client has signed a lease contract for with the land owners (signed on 27th April 2018).

The turbine layout will be revised iteratively as technical assessments are undertaken to determine the developable area and locations at which turbines should be placed to maximise wind generation but minimise impacts to the receiving environment and risks to the Project. The Project will use the most efficient technology available for the site at the time of construction. The exact model of turbine will be determined later in the development process.

Figure 1. Layout and Micro-siting for Sólheimar Windfarm



2.2 Turbine Technology and Layout

Currently, the proposed Phase 1 of the Project consists of up to 20 turbines, with a total indicative installed capacity of 112 MW. Phase 2 consists of seven turbines, with an indicative installed capacity of 39.2 MW.

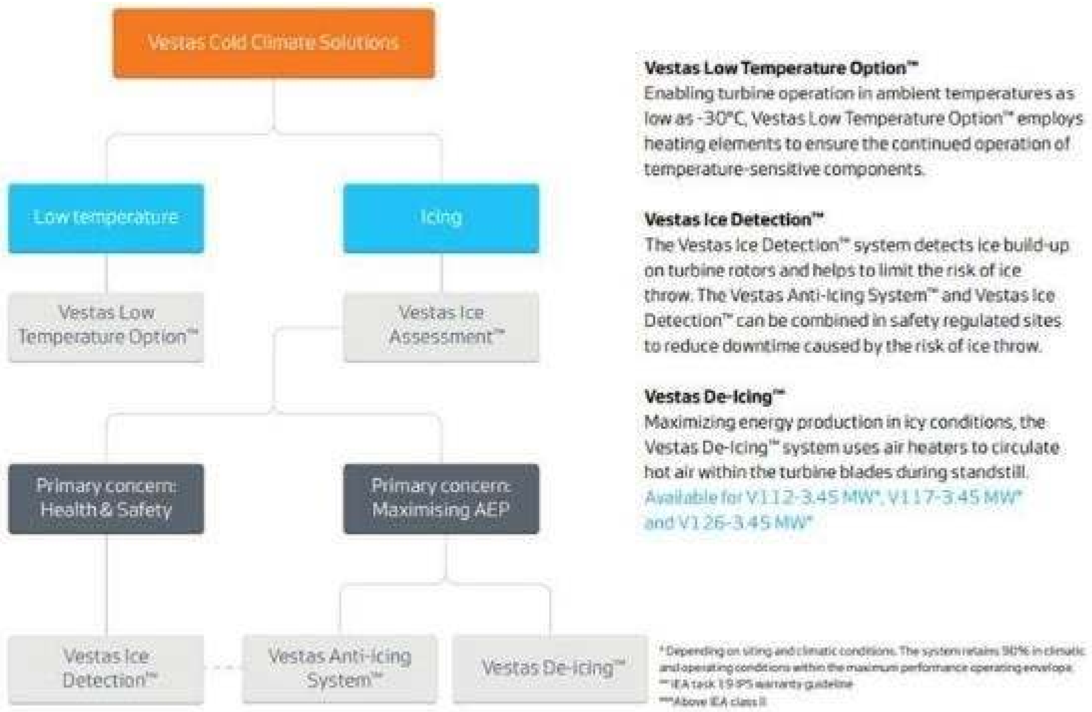
The Project will use Type 1 wind turbines that are designed for cold climates. A Type 1 wind turbine is characterized by a Squirrel-cage Induction Generator (SCIG), which is connected directly to the step-up transformer. The turbine rotates at a speed that closely follows the electrical grid frequency. The speed is controlled by the pitch angle of the blades. Under steady conditions a given wind speed will result in a near linear turbine speed, torque characteristic. Due to the mechanical inertia of the system, sudden changes in wind speed result in a limited rate of change in electrical output.

The Type 1 wind turbine technology includes:

- De-icing and anti-icing system: blades heated and surfaced with water-repellent coating; and
- Automatic speed regulation according to air temperature and humidity that avoid ice formation or ice throw.

Figure 2 provides an example of existing turbine technology for use in cold climates.

Figure 2. Example of Wind Turbine Technology for Cold Climates



Source: Vestas 2019

2.3 Project Components

The Project will comprise the following components:

- meteorological mast;
- turbine foundations;

- up to 20 turbines in Phase 1 and seven additional turbines in Phase 2;
- crane platforms for each turbine;
- electric cables between wind turbines and connection to the grid (everything is underground);
- communication fiber network between wind turbines and substations (the burying of the electricity and communication networks are shared;
- a substation allowing the power injection onto the Landsnet grid ;
- site office and laydown area ; and,
- new site access from Road 59 and on-site access road network, seeking use existing paths as much as possible.

The wind turbines are made up of three parts: a tower, a nacelle and the rotor blades. At this stage of the project the turbine model has not been chosen but it could be equivalent to the Vestas V162 5.6MW. This model's turbine hub height is 119 m and the turbine blades are 162 m in diameter.

Each turbine will require a steel reinforced concrete foundation of maximum 30 m in diameter. Crane pads and storage areas will be located at each turbine site (approximately 2,000 m^2 total). This type of foundation is easily removable and 100% recyclable as it consists only of steel and concrete.

The distance between turbines is dependent on the model selected, approximately equivalent to three times the diameter of the turbine blades. The final distance has been determined to minimize wake losses. Turbines will be sited a minimum of 500 m from any residential buildings to ensure occupants are not affected by operational noise emissions; this distance could increase based on noise modelling to be undertaken through the ongoing ESIA process.

The electricity generated by the turbines will be collected via buried connection cables to the substation within the Project site. Transformers in the substation will then change the voltage of the electricity for evacuation via HV cables into the grid.

The substation will allow the connection of the project to the grid. This substation is located below the existing HV line (Glerárskógarína 132 kV power line) near the entrance to the site from Road 59 (two location options are currently being considered, see Figure 1).Preferably, the Project will connect into the national grid system via a substation to be built through the existing HV line that runs between the substations at Glerárskógar and Hrútatunga. This HV line crosses through the site, running adjacent to Road 59.

The substation allows the connection of the project to the closest existing transmission lines. This substation is located below the existing HV line (Glerárskógarína 132 kV power line) near the entrance to the site from Road 59 (two location options are currently being considered, see Figure 1).

Preferably, the Project will connect to the national grid system via the existing HV line that runs between the substations at Glerárskógar and Hrútatunga. This HV line crosses through the site, running adjacent to Road 59.

New compacted gravel access roads will be constructed within the site boundary, connecting the site entrance to each turbine and the substations. The MV connection or collector cables carrying electricity generated by the turbines to the collector substation will be buried alongside the new onsite access road network.

2.4 Construction

Based on Table 1 and the definitions of the IFC categories, the construction components that make up the Project are set out in Table 1.

Table 1. Classification of Project Components

IFC Category	Project Component
Core component	■ Site access and on-site access roads, meteorological mast, foundations, crane pads, turbines, switchgear and cabling, temporary laydown areas, transformer, collector substation compound (substation and site office), and grid connection substation.
Associated facilities	■ Existing nearby offsite quarry (e.g. Haugur vestan Sellækjar) used to supply additional aggregate to the site for gravel needed for the crane platform and on-site access road construction (extraction of soil for the foundations will be reused to minimize raw quarried material). ■ Connection to the grid. ■ Road transport of construction materials and equipment.
Third party activities	■ Waste transport and disposal sites in Búðardalur or larger waste disposal facility (e.g. in Reykjavik) ■ Existing concrete batching plant (to be selected during the ESIA studies) ■ Port for delivery of construction materials

2.4.1 Access and Logistics

Vehicle movements generated by the following Project activities will be calculated for use in the ESIA process:

- Delivery of turbine components (including an indicative delivery schedule);
- Delivery of excess aggregate required for foundations to be sourced from a nearby existing quarry (e.g., Haugur vestan Sellækjar);
- Delivery of concrete from an existing, offsite concrete batching plant.

The turbine components will be imported and transported from a port to the Project site. There are currently four route options being considered using the existing public road network.

2.4.2 Turbine Foundations

Each wind turbine foundation pad diameter is expected to be up to 30 m. However, final design (i.e., exact dimensions, depths and reinforcement requirements) will be conducted after completion of geotechnical surveys.

2.4.3 Cable Laying

The turbines will be connected to the collector substation on-site using a buried MV cable network. These buried cables will run alongside the on-site access roads and therefore will not require any additional land take than the construction corridors required for the road network.

2.4.4 Substation

The substation ensures the connection and power injection to the grid system. The location of the substation depends on the existing transmission facilities surrounding the project.

For Solheimar project, the preferred solution is to build the substation through the existing HV line that runs between the Glerárskógar and Hrútatunga substations. Other alternatives are connecting directly to the substations in either Hrútatunga or Glerárskógar.

If there is no transmission lines close to Project area, a new transmission line is built between the Project substation and the closest existing transmission line or substation.

The substation (around 2500 m^2) will consist of MV switchgear, 1 to 3 HV power transformers, a HV switchyard, meters, protection devices, SCADA room , control room and office. It also includes a temporary construction laydown area and potentially, offices, basic amenities for the operation and maintenance team, bathroom, kitchen, and storage room.

2.4.5 Access Roads and Crane Platform Area

New compacted gravel access roads will be constructed on-site connecting the entrance of the site to each turbine and substations. The on-site road network will connect to the existing public road and used during construction and operation.

2.4.6 Public Road Network

Alternative routes to access the Project site via the public road network will be assessed through a dedicated survey, in consultation with the Icelandic Road the Coastal Administration and the wind turbine provider. All public roads will be reinstated at the end of the construction phase. Some junction improvements are likely to be required, this will be further investigated through the later stages of the development process.

2.4.7 Workforce

For the 12-month construction period, during the busiest periods, it is expected there will be up to 100 temporary staff employed on the Project site. Work on-site will likely be limited during the winter months (December – February) due to cold temperatures and minimal daylight hours.

2.4.8 Resource Use, Emissions and Discharges

2.4.8.1 Resource Use

Permanent and Temporary Land take

During site preparation and construction, less than 1% of the total site area of 3,200 ha will be required. A summary of temporary Project land take is described in Table 2 below. These land take areas are indicative, based on the current design.

Table 2 Summary of Expected Temporary and Permanent Project Land Take

Project component	Estimated dimensions	Area (km^2)	Area (ha)	Land take duration
Wind turbine an platform area				
Foundation	up to 30 m diameter	0.019076	1.90755	Permanent
Platform	1610 m^2	0.043470	4.34700	Permanent
Length (m)	46			
Width (m)	35			
Met mast (Three small foundation and base of the mast)		0.000004	0.0004	Permanent
New on-site access roads (including site entrance modification and undergrouns collector cable)		0.108	10.8	Permanent
Length (m)	*4000*			
Width (m)	4,5			
Underground collector cable (under access roads)	MV cables will be buried alongside the access roads and therefore land take is considered as part of the access road land take.			Permanent
Collector substation compound (i.e. substation, site and maintenance office*)	2100 m^2	0.002100	0.21000	Permanent
Length (m)	70			
Width (m)	30			
Grid connection substation	900 m^2	0.000900	0.09000	Permanent
Length (m)	30			
Width (m)	30			
Total (Permanent)		**2.531996**	**253.199550**	
Crane Hardstanding**	2240 m^2	0.060480	6.04800	1 month***
Length (m)	160			
Width (m)	14			
Compound/material laydown areas****	1640 m^2	0.044280	4.42800	10 months
Length (m)	82			
Width (m)	20			
Total (Temporary)		**0.104760**	**10.476000**	

*an additional option to move the Operations and Maintenance office to the nearby village, is being considered which would further reduce permanent land take.
** hardstanding areas will be left if this removal interferes with the turbines in operation.
***The construction team will undertake a phased approach; therefore, construction areas will be fenced off (i.e. made inaccessible to land users) for only up to 3 months at any one time.
****This includes a storage area for turbine components once delivered on site. This area may be relocated off-site if another, more suitable location on the route between the receiving harbour and the site is identified.

Water Requirement

During construction, concrete will be produced at an offsite batching plant. Water requirements on-site will primarily consist of water for domestic purposes-drinking water for the construction teams and to clean concrete top trucks. For this a concrete waste water filtration system will be put in place.

Figure 3. Concrete waste water filtration system

Raw Materials

Raw material for construction will consist of the extracted soil from digging the turbine foundations, any additional aggregate required will preferably be extracted from an offsite, possibly from an existing open quarry near the site.

Oil Requirement

Depending on the turbine model used, up to approximately 500 litres of oil will be required per wind turbine over a five-year period for gearbox maintenance activities. Wind turbines are equipped with a double retention system preventing these oils, which are recyclable, from ending up in the natural environment. Note that some wind turbine model (i.e., Enercon, Siemens) do not require oil usage, They are called Synchronous wind turbines. They will be also considered when choosing the wind turbine model for this site.

2.4.8.2 Emissions

Emissions during construction will arise predominantly from the use of generators and vehicles. The Project will cause localised, temporary impacts on air quality due to on-site construction activities. The likely emissions from construction activities will include the following:

- fugitive emissions from site clearing, digging, filling, material handling, transportation, use of construction machinery, etc.;
- fugitive dust emissions from vehicular access along unpaved roads; and

- vehicular emissions from increased traffic volume from vehicles used for transport of construction material; transportation of wind turbine generators and accessories.

Under normal operations there will be no gaseous emissions from the operating areas.

2.4.8.3 Discharges

Waste Generation

Waste generated during construction will likely consist of:

- Construction related waste such as excavated material, metal off cuts, etc.
- Domestic and solid waste (labour activities);
- Packaging waste (containing wood, cardboard and other recyclables);
- Liquid waste (welfare facilities); and top truck cleaning made of geotextile filtration system;
- Hazardous wastes (e.g. gear or lubricating oils during operation).

A high-level review of local/regional waste processing facilities currently available to receive Project waste (e.g., in Búðardalur or Reykjavík) will be included in the ESIA study to inform the development of an appropriate Waste Management Plan.

Sewage will also be produced on-site, and thus portable toilets will be installed on a designated space on the construction site. These will be maintained and emptied regularly to a suitable processing facility.

2.4.9 Estimated Construction Timeline

It is anticipated that the construction phase of the Project will last for a maximum of 12 months in total. However, due to seasonal constraints, site construction is likely to be limited during the winter months. If the construction needs to stop on site for an extended period, measures will be implemented to ensure the site is secure. Construction will be phased and organised within the construction window, which may need to be staggered over a two-year period.

2.5 Operations

The windfarm is designed to be operational for 25 years. Once operational the turbines will be monitored and operated from a remote-control room. During operation, windfarms require limited workforce

Regular maintenance will be required to ensure that the turbines are kept in optimal working order. Most day-to-day facility operations will be conducted remotely using computer networks and a small team. Some limited maintenance and repair activities may need to be undertaken occasionally on-site.

The turbines selected for the Project will be designed for cold climates and include industry standard safety features such as automatic switch-off, used during high wind speeds or grid unavailability and for better safety performance.

2.5.1 Turbine Maintenance

The Project will use wind turbines that are designed to cope with site's harsh sub-arctic climate and to withstand ice and heavy snowfall, thereby requiring minimal maintenance. The blades will be heated and covered with a water-repellent coating. The turbines' automatic speed regulation will adjust to air temperature and humidity to avoid ice formation and ice throws. The turbines will also be equipped with an automatic speed limit and shut down in the event of heavy wind conditions.

Preventative measures that will be taken for turbine maintenance include maintenance of the turbines' sensors and heaters, and regular inspection of the blades. The turbines can also be operated remotely in the event that they need to be switched-off when access to site is limited due to extreme weather.

2.5.2 Meteorological Mast

A new meteorological or 'met' mast has been erected on-site for wind studies. An on-site maintenance inspection is being carried out on the met mast at regular intervals to ensure the wind data is being recorded and stored correctly. Safety checks are also carried out at regular intervals to ensure the mast continues to be structurally safe.

2.5.3 Connection Cables

The MV connection cables will be maintained during operation. Once the MV cables have been installed only intermittent monitoring and maintenance will be required.

2.5.4 Traffic

Traffic during operation will be limited to maintenance vehicles and movement of employees around site.

2.5.5 Workforce

During the operational phase, it is expected that eight to 10 staff will be employed by the Project for supervision and preventative maintenance. An additional two to four curative maintenance staff will be supplied by the turbine manufacturer for yearly maintenance.

2.6 Decommissioning

Following the end of the Project's operational life (i.e., at least 25 years following the start of operations) the Project will be either repowered or decommissioned. A detailed decommissioning or repowering plan will be prepared and submitted to the NPA prior to commencing any decommissioning works. Because detailed decommissioning plans will not be available for many years, this phase is not evaluated in detail. Decommissioning will likely generate traffic associated with worker movements, disassembly of turbines, and transport of materials away from the site, along with temporary or permanent road infrastructure improvements necessary to facilitate those activities. Overall, it is assumed that decommissioning will result in impacts similar in character and significance to those identified for the construction phase but over a shorter period (i.e., three months). The dismantling of wind turbines is extremely fast. The entire foundation is recyclable and it is possible to dismantle all roads. However, it will be possible to leave portions of new paths useful for the farm if requested by the farmer (being understood that we mostly use pre-existing paths that we strengthen).

Figure 3. View from South to North Towards the Wind Site

3 Baseline Conditions

3.1 Overview

The Project site covers an area of approximately 3,200 ha (not including area for associated facilities such as the borrow pits/quarry). The site is typified by relatively smooth terrain composed of fine soil and basalt rock[1]with rolling hills and numerous lakes, rivers, and water bodies. The vegetation in the area is comprised of grasses and primitive species, primarily of mosses and other bryophytes.

There is one farm within the Project site; however, the surrounding area is sparsely populated, with small communities to the east (Borðeyri) and west (Búðardalur), with a few farms in the area along Road 59 which crosses through the site.

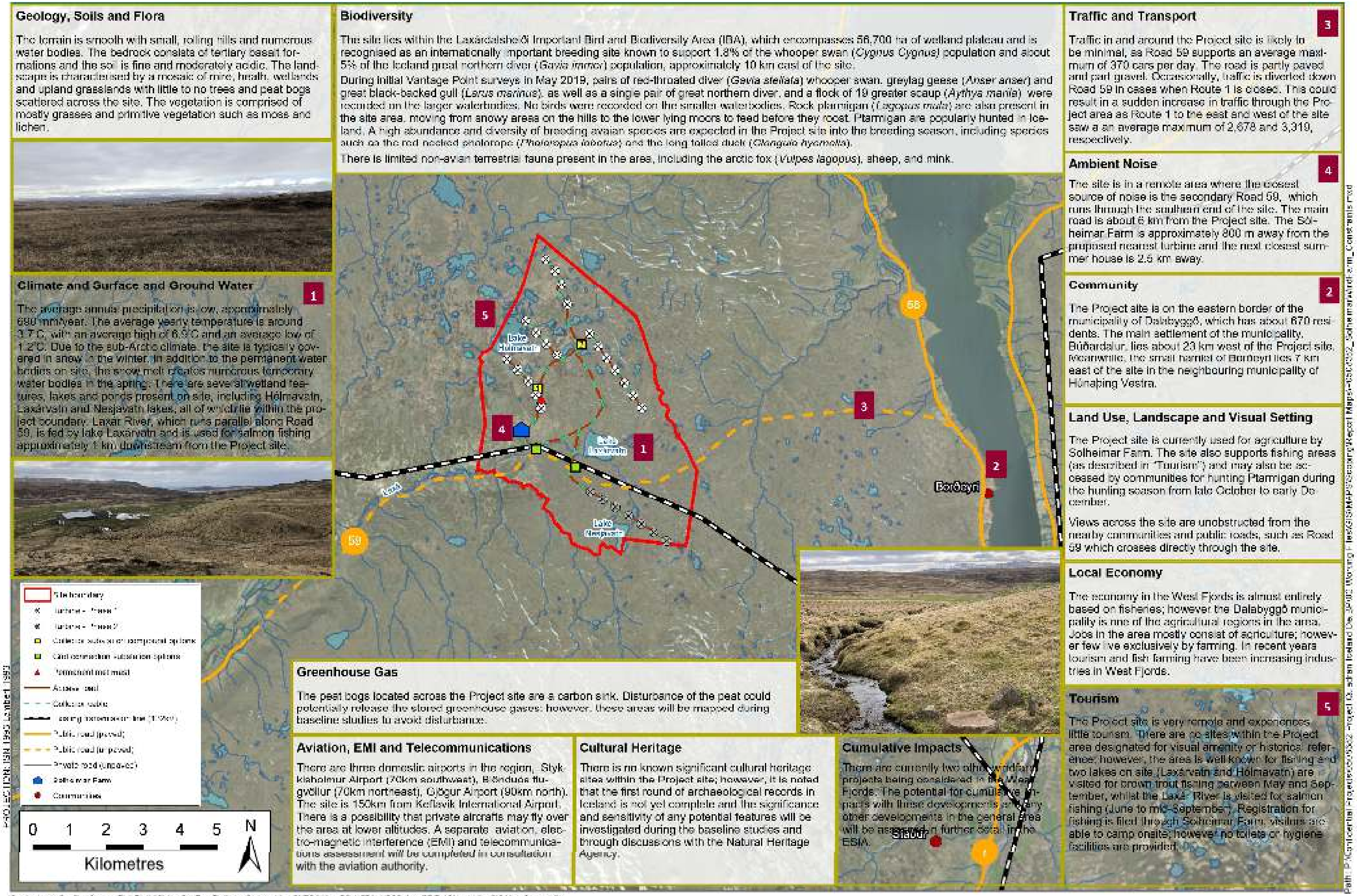
The Project site is located within the Laxárdalsheiði Important Bird and Biodiversity Area (IBA), designated for supporting internationally important breeding populations of great northern diver (5% of the Icelandic breeding population) and whooper swan (1.8% of the Icelandic breeding population).[2]

There are limited footpaths within the Project site; however, the area may be accessed by hunters and fishermen. As sheep in Iceland are free-roaming, there is a possibility for the site to be accessed by communities during the herding season or "Réttir" in September. There are no known significant cultural heritage sites within the Project site.

A summary of key environmental and social baseline sensitivities identified during the scoping visit is presented in Figure 4 next page.

1 Haukur Jóhannesson, 2014, Geological Map of Iceland- Bedrock Geology, map, 2nd edition, scale 1-600,000, Icelandic Institute of Natural History, available from: http://en.ni.is/outreach-and-publications/publications/maps/geological-maps/600000.html andBirdLife International (2019), *Important Bird Areas factsheet: Arnarvatnsheidi-Tvidaegra*. Downloaded from http://www.birdlife.org on 17/05/2019.

Figure 4 : Key Environmental and Social Baseline Conditions



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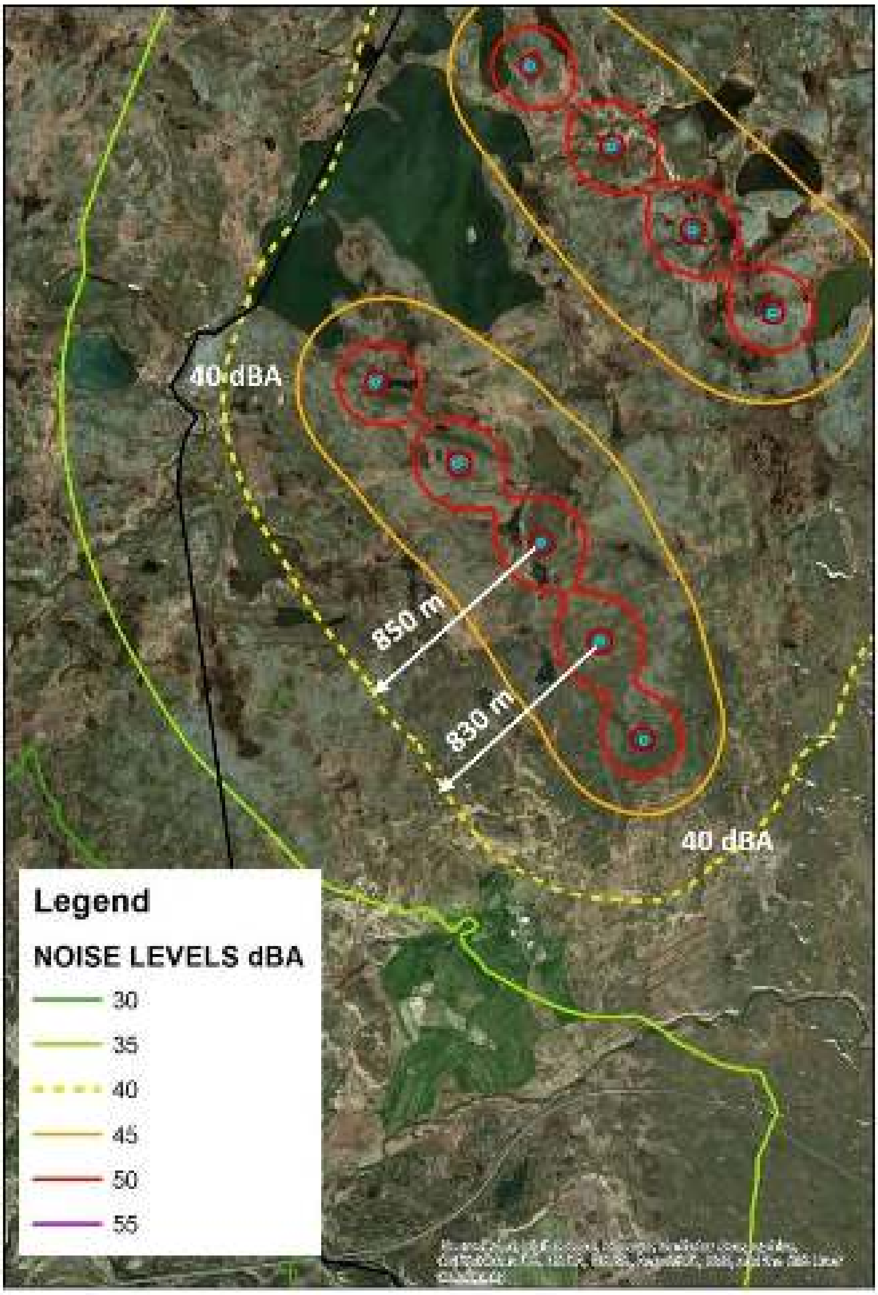
3.2 Ambient Noise

Construction activities, including the induced road traffic, have the potential to produce noise which may lead to an increase in background noise levels in the local vicinity. These impacts will be temporary in nature and will be confined to a localised area. Windfarm operation also has the potential to produce noise which will extend for the duration of the Project and will be widespread across the broader site where turbines are located. Icelandic noise regulation (n. 724/2008) specifies limits of 50 dBA daytime and 40 dBA night for residential areas. There are also limits regarding summerhouses (Frístundabyggd), set at 35 dBA; however, summerhouses are not near the site area.

Figure 5 Modelled Standoff Distance from Sensitive Receptors



Source: ERM 2019

A preliminary assessment was conducted to calculate the minimum standoff distance to meet the night-time limit of 40 dBA, using the following assumptions:

- Turbine model: V162 5.6MW
- Hub height = 119 m
- Rotor diameter = 162m
- Lw = 106.8 dBA (max)

Figure 5 shows the minimum standoff distances required for compliance with the night-time noise limit of 40 dBA. This model follows the worst-case scenario turbine model specifications and hub height.

Although Sólheimar Farm is within 800m of Project activities, residents are unlikely to experience excess noise levels during operation. Nonetheless, to further understand any potential noise impact to sensitive receptors, 24-hour noise measurements will be performed at Sólheimar Farm (i.e. the nearest sensitive receptor) in compliance with ISO 1996-2 requirements. These measurements will be used to establish a baseline of current noise levels at Sólheimar Farm.

In summary, the key issue identified is that residents of Sólheimar Farm may experience an increase in background noise during the construction (temporary) and operation of the Project (although not in excess of 40 dBA).

3.3 Surface and Groundwater

Construction of the Project has the potential to impact existing surface water drainage systems within the Project study area, through the construction of access tracks or roads, and the provision of watercourse crossing structures, such as bridges, culverts, or fords. Usual construction activities also have to potential to have an impact upon the water quality of surface and groundwater sources through potential mobilisation of sediments or spillage of chemicals or fuels. But in this case no use of chemicals and no stock of fuels will be on site.

These potential impacts which will include a robust baseline mapping exercise to identify watercourse crossing locations, production of a watercourse crossing schedule and allocation of appropriate crossing methods which will seek to minimise impacts as far as is reasonably practicable.

At this stage, it is likely that concrete required for construction will be sourced from an offsite batching plant and transported to site. Therefore, the water requirement on-site will be reduced to water for domestic purposes and drinking water for the construction teams.

Further consultation and baseline studies (site walkover) will be conducted to understand the constraints and locations of the surface and groundwater at the site. Any potential impacts will be mitigated and managed through avoidance, best practice design, good construction practice and industry standard measures.

3.4 Biodiversity

3.4.1 Habitats and Flora

The majority of habitats within the Project site are common and widespread (dominated by heath, bog, mosses and grasslands) with no conservation protect; some parts are used as pastures and harvested for hay. Within the proposed site there are several wetland areas which fall under article

61 of the nature conservation Act no. 60/2013 on special protection.[3] There are also peat bogs located across the Project site which are an important habitat supporting biodiversity and act as a carbon sink. These areas will be mapped in the ESIA process with the aim to avoid disturbance.

The habitats on-site will be categorised according to the descriptions published by the Icelandic Institute of Natural History (IINH).[4] These habitats will be ground-trushed and more detailed mapping conducted, and which will be used to inform the design of the Project. It is expected that avoidance of the protected wetland habitats can be avoided through micro-siting of turbines. The loss of habitats and flora as a result of the Project will be calculated and the significance of the impact will be assessed.

To align with IFC Performance Standard 6, the ongoing ESIA includes an assessment of the presence of Modified, Natural and Critical Habitat within and around the Project Site, in line with the guidance set out in IFC Guidance Note 6.[5]

3.4.2 Impacts on Birds

Baseline Information

During initial site and Vantage Point (VP) reconnaissance surveys undertaken in early May 2019, relatively low bird abundance and diversity was recorded.

Passerines recorded on-site included low numbers of meadow pipit (*Anthus pratensis*), snow bunting (*Plectrophenax nivalis*), wheatear (*Oenanthe oenanthe*) and redwing (*Turdus iliacus*). Ravens (*Corvus corax*) were infrequently recorded flying through the site. A single flock of 24 golden plover (*Pluvialis apricaria*) were recorded flying through the site. Small numbers of redshank (*Tringa totanus*) and snipe (*Gallinago gallinago*) were recorded. Three ptarmigans (*Lagopus muta*) were recorded. Ptarmigan are commonly hunted in the area around the Project site during the hunting season from late October to early December. Ptarmigan hunting is intended for personal use and only a limited number of hunting licenses are issued each year.

On the larger waterbodies surveyed, pairs of red-throated diver (*Gavia stellata*) whooper swan (*Cygnus cygnus*), greylag geese (*Anser anser*) and great black-backed gull (*Larus marinus*) were recorded, with whooper swans already sitting on nests. A single pair of great northern diver (*Gavia immer*) was recorded on a water body in the south of the Project site. A flock of 19 greater scaup (*Aythya marila*) were recorded feeding on the largest waterbody. No birds were recorded on the smaller waterbodies. Low numbers of whopper swans (approximately 6 birds) were recorded foraging on upland grassland to the south of the Project site, with approximately 20 birds foraging on grass fields at Sólheimar farm. Approximately 30 birds were recorded foraging on grass fields further down the valley to the west of the Project site. Later in the breeding season, higher abundance and diversity of breeding species is expected in the Project site, including red-necked phalarope (*Phalaropus lobatus*) and long tailed duck (*Clangula hyemalis*).

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[3] National Institute of Natural History. (2017). *Species and birds in Iceland- Laxardalshedi* [Online]. Available online at: https://www.ni.is/node/16139.

[4] Jón Gunnar Ottósson, Anna Sveinsdóttir og María Harðardóttir, ritstj. (2016). *Vistgerðir á Íslandi*. Fjölrit Náttúrufræðistofnunar nr. 54. 299 s.

[5] IFC (2019). *Guidance Note 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources*.

Potential Impacts

During construction of the wind farm, potential impacts include habitat loss and disturbance to resident or breeding birds. During operation of the turbines, there is the potential for impacts to occur on birds from habitat loss, displacement (i.e., birds avoiding the wind farm and surrounding area), direct collision with the turbine blades or other infrastructure and barrier effects in which birds are deterred from using normal routes to feeding or roosting grounds. Regarding the possibility of collision, the Lucia group, to which Quadran Iceland belongs, has innovative proven technology at the global level to avoid any deadly impact of medium-sized and large-scale birds. It uses HD cameras placed onto the hub that detects and tracks, day and night, birds approaching the wind turbine. In line with the detection parameters, which can be scaled according to the installation site requirements, the device engages automatically scaring and/or regulation actions. These actions are automatically stopped as soon as the birds are off the risk zone. A part of this technology can be used to best estimate the habits and trajectories of birds living on site or using it during prenuptial or postnuptial migrations. This technology is recognised and in use in several countries in Europe including Germany, France, Finland, Austria, Belgium, and the Netherlands.

3.4.3 Non-avian Terrestrial Fauna

Non-avian terrestrial fauna diversity and abundance is relatively low on-site, being largely restricted to small mammals and Arctic fox (*Vulpes lagopus*) but may be affected by disturbance due to the presence of vehicles, machinery and the workforce during construction, and through disturbance from noise of turbines during operation. Field surveys will record species diversity and relative abundance of non-avian fauna during the ESIA baseline studies.

3.4.4 Impacts on Fish and Aquatic Fauna

Construction of the Project is not expected to result in any significant alterations to the lakes or watercourses which support some fish species (e.g., salmon, brown trout) for site access or construction. A high-level consideration will be included, including consultation with stakeholders. No detailed assessment will be undertaken as any potential impacts will be mitigated and managed through Project design, good construction practice and industry standard measures.

3.4.5 Protected and Recognised Areas

The closest nationally protected area for nature conservation is the Geitland Nature Reserve, a lava field and glacier approximately 60 km south of the Project site. The closest Natural Monument to the Project site is the Kattarauga pond, approximately 50 km to the east.

The Project site is located within the Laxárdalsheiði Key Biodiversity Area (KBA)/Important Bird and Biodiversity Area (IBA), designated for supporting internationally important breeding populations of great northern diver (5% of the Icelandic breeding population) and whooper swan (1.8% of the Icelandic breeding population).[6] IBA/KBAs are not nationally protected but are internationally recognised sites identified by Birdlife International and Fuglavernd (Birdlife Iceland) as being of conservation importance for birds.

[6] Kristinn Haukur Skarphéðinsson, Borgný Katrínardóttir, Guðmundur A. Guðmundsson og Svenja N.V. Auhage (2016). *Mikilvæg fuglasvæði á Íslandi*. Fjölrit Náttúrufræðistofnunar Nr. 55. 295 s.

Impacts on the qualifying features of the Laxárdalsheiði KBA/IBA (whooper swan and great northern diver) are being assessed as part of the avian impact assessment, and potential impacts on the KBA/IBA will be assessed.

3.5 Tourism

The Project site is remote and sees little tourism. Should the main Route 1 be closed down and diverted through Road 59 due to adverse weather conditions, there could be heavier tourist traffic through the Project area, but this would only be temporary. Between May and the end of September the site may experience increased tourism due to fishing on the Laxárvatn and Hólmavatn lakes and the Laxár River; however, management of access to the site’s fishing areas is managed as visitors are required to register with Sólheimar Farm prior to accessing the site.

Project activities are not expected to significantly impact tourism in the area; however, on this topic engagement with the local community and the Icelandic Tourist Board conducted.

3.6 Cultural Heritage

Although there are no known significant cultural heritage sites within the Project site, this topic was assessed in October 2019 by the National Heritage Agency. Nothing of relevance was found during this asessment. The significance and sensitivity of any potential features within the footprint of the construction works will be also investigated through discussions with the National Heritage Agency and through stakeholder consultation. Any potential impacts will be mitigated and managed through good construction practice and industry standard measures.

3.7 Local Economy and Tax aspect

The impact of the Project on employment and the economy is expected to be positive. It is anticipated that unskilled roles will be available during construction. These will be temporary posts and will be advertised in local communities. The number of opportunities during operation will be significantly fewer and are likely to be filled by skilled workers.

Indirect opportunities will also arise through the procurement of goods and services, such as food supplies and construction materials, from the local market has the potential to result in positive impacts in the area by stimulating local small and medium sized business development and generation of profits.

The facility will also be a significant contributor to taxes for the entire production stemming from property taxes, taxes on labour as well as on profits.

3.8 Land Use and Land Take

There will only be insignificant temporary (short to medium term) land take during construction and decommissioning activities, with fencing limited to excavated areas. Permanent land take will be limited to the footprint of the Project infrastructure as the site area will be accessible while the turbines are in operation (less than 1% of the total leased area will be permanent land take). Site preparation, excavation and construction of foundations, and access roads will all result in disturbance, removal and occupation of land. Land within the permanent footprint of the turbines and roads will be unavailable for the duration of the Project, whereas land within the temporary footprint will be reinstated and can return to its previous land use during operation.

In summary, the key issue identified is land within the Project site made temporarily or permanently unavailable as a result of the Project; however, due to the distance of the Project site from neighbouring communities and temporary nature of the land take, it is unlikely to result in any significant impact. Any potential impacts will be mitigated and managed through good construction practice and industry standard measures.

3.9 Community Health, Safety and Wellbeing

3.9.1 Amenity

During operation, shadow flicker may impact nearby residential buildings. Shadow flicker occurs when the sun passes behind a wind turbine and casts a shadow. As the blades rotate, shadows pass over the same point causing an effect termed shadow flicker. The distance between a wind turbine and a potential shadow-flicker receptor affects the intensity of the shadows cast by the blades, and therefore the intensity of flickering. Shadows cast close to a turbine will be more intense, distinct, and focused. This is because a greater proportion of the sun's disc is intermittently blocked by the turbine.

Obstacles such as terrain, vegetation, and/or buildings occurring between receptors and wind turbines may significantly reduce or eliminate shadow-flicker effects.

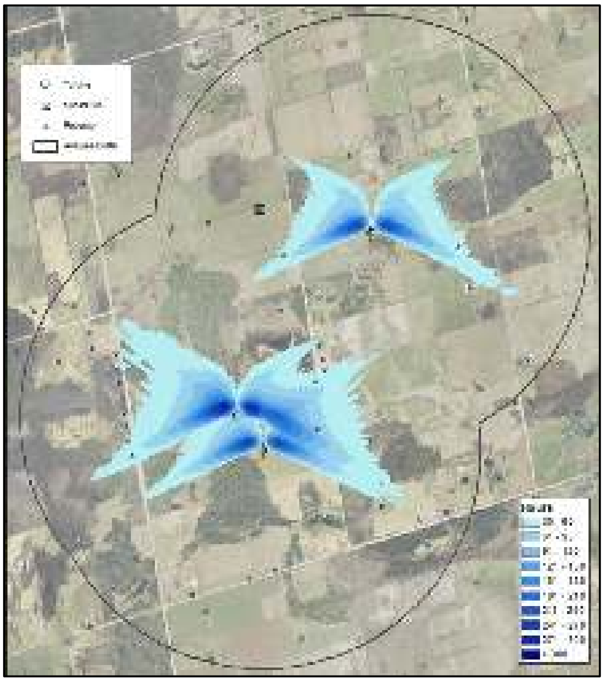
Shadow flicker may become a problem if individuals are exposed for extended periods; however, it is not generally considered a significant issue. It is important to note that shadow flicker is experienced most at higher latitudes, where the sun casts longer shadows.

The UK best practice guidelines state that shadow flicker assessment should be performed for receptors located within a distance of 10 rotor diameters from the turbines. Under this assumption and worst-case scenarios rotor diameter of 136m, if receptors are within 1.4km of the turbines then further assessment is required. The only sensitive receptor within 1.4km is Sólheimar Farm which is within 800m of the nearest turbine; therefore, shadow flicker modelling will be undertaken during the assessment to confirm if the current turbine layout is at an appropriate distance from Sólheimar Farm.

The shadow flicker effect has not been yet calculated for this project nevertheless, Figure 6 shows an example of shadow flicker effect.

This effect is concentrated around the wind turbines. When respecting a fair distance between habitations and wind turbines to limit noise disturbances, we automatically limit the disturbances due to the shadow flickering effect. There is no regulation on shadow flicker but we use the recommendations of the Schleswig Lander in Germany.

Figure 6. Example of shadow flicker effect



3.9.2 Public Access

Although it is the intention of the Project to maintain access to the area as much as possible, excavated areas of the site will be temporarily fenced off to manage public health and safety risks during construction and decommissioning.

There will be limited restrictions during operation whereby only the substations will be fenced off with access restricted, which is unlikely to affect public access to fishing and hunting areas on-site. An engagement programme with affected communities and land users, as well as appropriate signage/information boards will be required to minimize risks associated with restricted access.

3.9.3 Landscape and Visual

Views across the site are unobstructed and easily visible from Road 59 which runs through the site. Construction and operation of the wind turbines will change the existing landscape character as well as views from nearby communities and public road users. However, this area is very remote and does not experience heavy tourism. The next nearest farm to the site is 2.5 km away and the nearest village is approximately 10 km away. The site is also reversible to its original state.

The ongoing ESIA addresses stakeholder concerns and consider whether nearby farms and communities experience a meaningful change in views. It will also consider the change in landscape character during the operation of the Project. Data gathered during the ESIA studies will include generating photomontages to simulate the likely visual changes that would result from the proposed windfarm. In summary the key issues are as follows.

- Temporary changes to views across the site during construction due to construction machinery and the erection of turbines.
- Permanent changes to the landscape character of the area once the turbines are operational which may lead to a visual impact on communities within close proximity to the Project site.

3.9.4 Road Infrastructure

The Project will require the international transportation of oversized or heavy wind turbine components (blades, turbine tower sections, nacelle, and transformers) and cranes to site, from port.

A study will be undertaken to identify the route from the chosen Port (or alternate Port) to the site and to determine whether any road upgrades are required. The study will also review whether any roundabouts will need to be temporarily bridged to allow the oversized vehicles to pass. To reduce delays to other road users and to maximise safety for local communities along the transport route, the delivery of oversized loads is likely to take place outside of peak hours (i.e., at night).

An engagement programme will also be developed so that communities close to any transport routes are aware of health and safety issues associated with the movement of heavy loads to and from the site.

Any new access roads constructed to the Project site will be available for public use following construction completion which is anticipated to have a positive impact on overall road infrastructure capacity.

3.9.5 Telecommunications and Electromagnetic Interference

The operation of wind turbines can interfere with broadcasting and other telecommunication services by causing electromagnetic interference (EMI). The design of the Project will consider and, where necessary, incorporate the prevention and control measures set out in the IFC EHS Guidelines for Wind Energy.

This will include consultation with telecommunication operators in the area, if deemed necessary by the Post and Telecom Administration. Measures that will be implemented by the Project will be incorporated in the ESMP. A detailed assessment will not be undertaken as part of the ESIA but as a separate assessment, if required by the regulatory authorities. In fact, wind turbines may interfere with television reception by Hertzian waves but not with reception of GSM phones or satellite and fibre connected televisions. The only precautions concern the microwave radio networks and compliance with the radio relay. For this purpose, wind turbines must deviate from identified beams.

3.9.6 Aviation

The operation of wind turbines has the potential to interfere with aircraft safety (height of the turbines) and aviation radar (signal distortion - see EMI above). The Project will consult with the aviation authority during development of the Project. In the same way, civil aviation services must provide their recommendations in terms of lighting if necessary.

3.9.7 Waste Management

The Project will generate various wastes during construction, including black and grey water and sewage from the staff compound, which will need to be collected, segregated and disposed of in a controlled manner. Waste management services in the Project area capable of dealing with the types of waste generated by the Project are not known at this stage.

Good practice waste management (according to international guidelines) will be followed for all phases of the Project. These will be included in the EPC contractor commitments and detailed in full in the management plans to be developed/ implemented for the Project. If correctly managed, it is not expected that waste will have any significant impact on the local natural or social environment.

Nonetheless, a high-level assessment will be undertaken to establish a baseline of any existing waste management facilities (local or regional) that would be identified to receive Project waste.

3.9.8 Greenhouse Gas Assessment

IFC Performance Standard 3 requires quantification of greenhouse gas emissions, in order to determine whether these are likely to exceed the significance threshold of 25,000 tonnes carbon dioxide equivalent (CO_2e) per year during the operational phase of the Project. The assessment is limited to scope 1 and scope 2 emissions sources only, which represent the direct emissions within the physical Project boundary and indirect emissions associated with offsite production of energy (i.e., purchase electricity). If this threshold is exceeded, cost-effective mitigation measures should be proposed as part of the assessment to reduce annual Project emissions.

Emissions that arise during the operational phase of a wind farm are primarily due to transportation of people and equipment during maintenance activities, powering up the generator or use of the braking system. Any emissions associated with the generation of electricity for use by the Project will be minimal due to the low carbon intensity of the Icelandic grid; however, peat bogs, a carbon sink, are located in areas within the Project site boundary. Disturbance of the peat during construction could result in the release of the stored GHG's; however, these areas will be mapped during the baseline studies with the aim to avoid disturbance of these sites.

Lifecycle analysis[7] concludes that <10% of emissions during a wind turbines total lifetime are associated with operations and maintenance, with more than 85% associated with the materials and turbine manufacture. The facility will recover its emission quota in less than nine months.

It is not expected that the Project will exceed the annual operational 25,000 tonnes of carbon dioxide equivalent emissions threshold.

3.9.9 Climate Change Risk Assessment

IFC Performance Standard 1 requires projects to consider how they may be impacted by the climate through a climate change risk assessment (CCRA). This includes identification of potential direct and indirect climate-related adverse effects that may affect the Project during its life-cycle and then define monitoring programme and mitigation and adaptation measures.

There are few climate variables which are likely to impact the Project. The key variable is wind, which the Project relies on. Wind turbines are designed with a safety mechanism forcing shut-down, should wind speeds get too high.[8] High level climate projection data for Iceland (from the IPCC AR5 [9]) projects that from 2040-2059, in a high emission scenario (RCP8.5) with unfettered GHG emissions and an absence of climate change policies, there will be -5 to +15 days without noticeable wind compared to

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[7] Thomson, R. & Harrison, G. (2015). *Life Cycle Costs and Cabon Emissions of Onshore Wind Power. Climate Exchange*. Available online at: https://www.climatexchange.org.uk/media/1463/main_report_-_life_cycle_costs_and_carbon_emissions_of_onshore_wind_power.pd

[8] Office of Energy & Renewable Energy (2017). *How Do Wind Turbines Survive Severe Storms?*, Energy.gov. Available online at: https://www.energy.gov/eere/articles/how-do-wind-turbines-survive-s.

[9] IPCC (2014): *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland

1986-2005. This level of wind would not be sufficient for wind power generation; however, the number of days is not expected to have an overall negative impact on-site operation.

Predicted changes in precipitation and temperature are unlikely to have a material impact on the Project. The Project is not near the coastline, so is at low risk from sea level rise and coastal flooding. There is a river on-site, but flood risk is considered to be low due to the size and nature of the river.

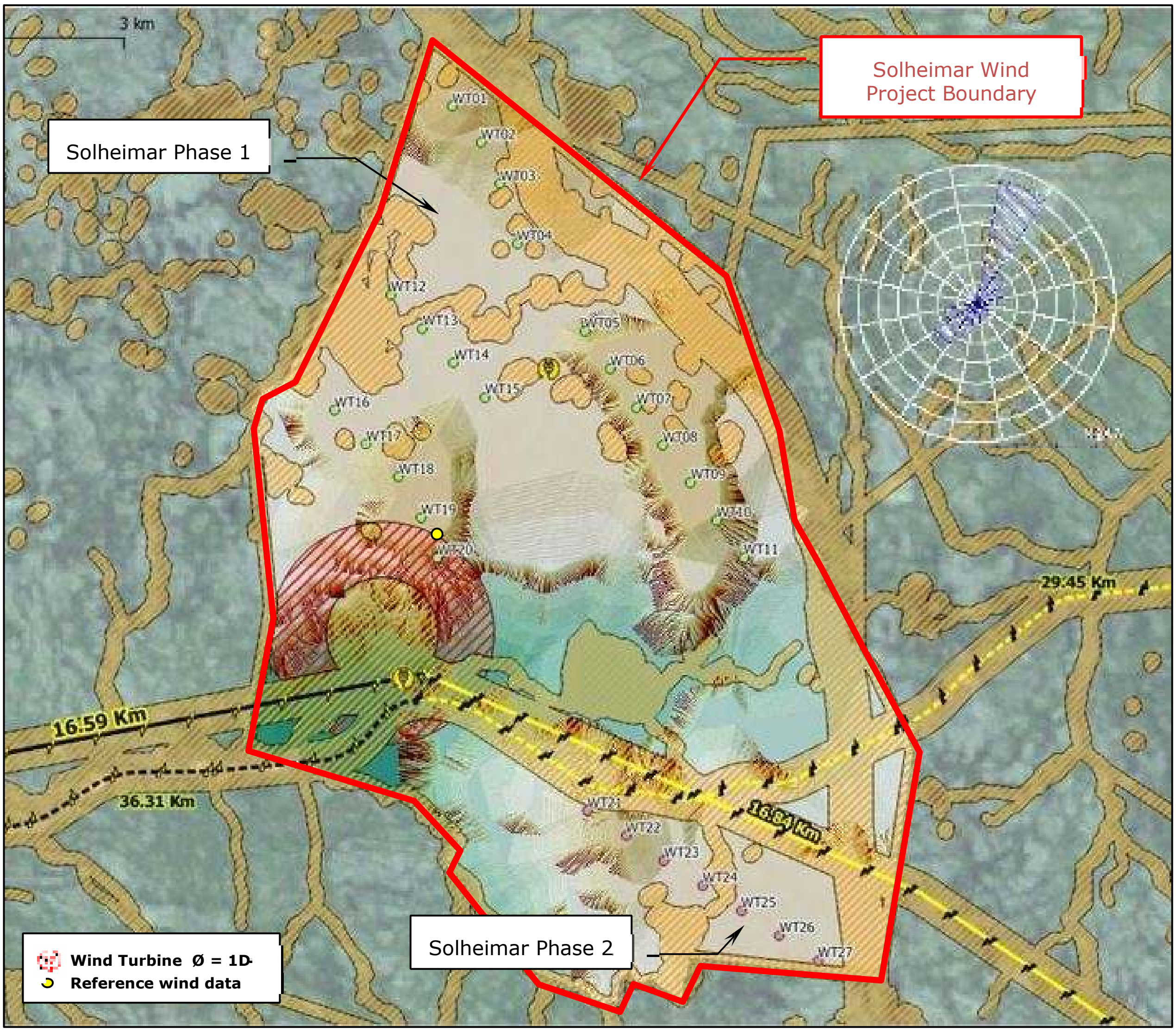
3.9.10 Wind Energy

For studying the energy capabilities of the site, a micro-siting was conducted. The optimized layout proposed comprises of 27 Vestas V162 5.6 MW wind turbines, totalling an installed capacity of 151.2 MW. The make and the model are subject to change when more wind data is available and consequently the position of each WTG might change a little to optimize the energy and minimize wake losses. However, the present configuration is thought to give a good approximation.

In the arrangement proposed, the machines were positioned in order to make better use of topographical features, reducing the influence of transition areas between roughness contours and facilitating the construction of internal grid and internal ways. Moreover, the minimization of losses due to the wake effect between machines was also considered. These factors have direct consequences on the maximization of energy produced and reduction of investment costs with the power plant infrastructure

Figure 7 shows the layout suggested for the Sólheimar Wind Farm, including the constructions areas .

Figure 7. Layout, Wind Rose and restrictions for the Sólheimar Wind Farm



The reference power curve was corrected to the typical air density of the site by linear interpolation from two consecutives guaranteed power curves, encompassing the typical site air density (1.224 kg/m3). It was considered representative for the entire period evaluated due to the low variation in the site air density throughout the year. In this study, a WAsP model program was inputted with WTG power curves adjusted for 1.224 kgf/m2 air density, by IEC approach, considering the level of 340 meters (a.s.l.). For vertical extrapolation of air density purposes, a lapse rate of 6.5 K/km and a sea level standard pressure of 1,013.25 hPa were assumed. In short, the power production potential of the simulated wind farm is excellent, and the project is thought to be profitable with prevailing market condition.

Figure 8. Energy Information for the Proposed Layout of Sólheimar Wind Farm

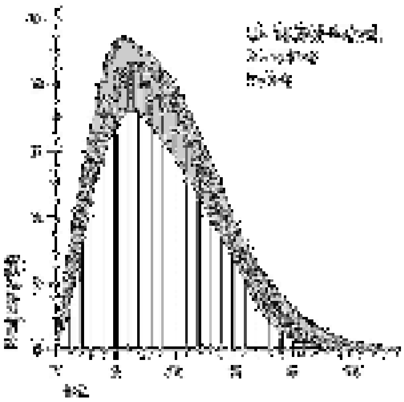
SOLHEIMAR WIND POWER PROJECT (REFERENCE WIND DATABASE – VORTEX MAST PRODUCT)

Main Results:

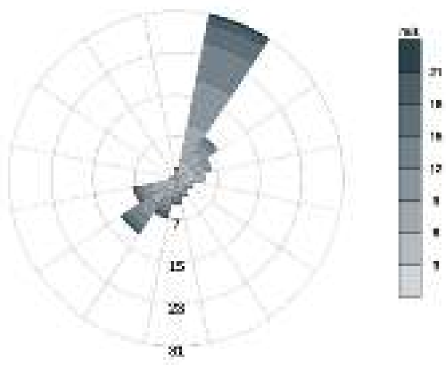
	100 meters	*50 meters*
Average wind speed:	8.88 m/s	8.19 m/s
Weibull form factor, k:	2.00	1.99
Weibull scale factor, A:	10.1 m/s	9.3 m/s
Average power density:	830 W/m²	660 W/m²

Main Graphs:

Distribution of occurrences (100 meters)



Wind Rose (100 meters)



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Vestas 2019

World Bank's EHS General Guidelines (2007),