EXAMPLE Solar Farm Wind Loading Report

Author Name and Information

Company Name

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Scope

The Wind Loading Design Report provides a comprehensive analysis of the wind loading on the EXAMPLE NAME Solar Farm, including considerations of varioussite specific factors and parameters . The analysis includes detailed calculations and assessments of wind velocity, pressure distributions,and the resulting forces on the structure. The purpose of this report is to ensure the structural integrity and safety of the solar farm under various wind conditions.The methodologies and results presented herein follow industry standards and are based on the latest available data and engineering principles. When required the designconsiderations use appropriate assumptions as part of the process allowed under the applicable normative framework, if not stated otherwise the most conservativeapproach is always implemented. The particular Design Standards used for the calculation and verification of applied loadings are detailed below.

Design Standards and Guidelines:

1. Eurocode 0: Basis of Structural Design (EN 1990);
2. Eurocode 1: Actions on Structures - Part 1-4: General Actions - Wind Actions (EN 1991-1-4);
3. BS EN 1991-1-4:2005 + A1:2010;

Geometry

The effect of the wind on the structure (i.e. the response of the structure), depends on the size, shape and dynamic properties of the structure.The Wind Loading Design Report is reliant on the definition of two lines of technical information - overall structural parameters, described in the Geometry section of the report and the overall wind velocity and pressure profile, dependent on the site specific conditions. For the purposes of this Wind Loading Design Report, to calculate the forces and moments acting upon the structure, the first step is to define the geometry on which wind loading actions apply. For the purposes of this report the geometry of the PV module structure can be described as a simple parallelogram, defined by the following key characteristics:

Structure Height (H):	4 [m]
Structure Length (L):	3.313 [m]
Structure Width (W):	4 [m]
Height above Ground (z):	5 [m]

Site Specific Factors

The Site-Specific Factors are the parameters of the engineering design related to the environment's global and local geography, topology, features and patterns of the terrain that shape the movement of wind masses in the vicinity of the site as well as the probability and statistical significance of events caused by said factors. These factors, similar to the geometry, are very much site specific, capturing the individual intricacies of each project and surrounding environment. Most of the coefficients and values are taken at face value and do not require muchconsideration outside of the context of the site and the design process. The values provided in this section are derived intrinsically and are not relianton complex modelling or calculation procedures.

Detailed descriptions and derivations for those factors and their respective values exist in Europe as part of National Annexes and are further explained in the context of the design by Eurocode 1: Actions on Structures - Part 1-4: General Actions - Wind Actions (EN1991-1-4), but are also briefly summarized in the report.

Distance from Building to Shoreline (L_distance_shore):	30 [km]
Altitude above Sea Level (A_altitude):	115 [m]
Altitude Factor (c_alt_factor):	1.115
MAP Wind Velocity (V_b_map_wind_velocity):	24.5 [m/s]
Directional Factor (c_dir_factor):	1.0
Season Factor (c_season_factor):	1.0
Shape Parameter (K_shape_parameter):	0.2

Air Density (p_air_density):	1.226 [kg/m^3]
Exponent (n_exponent):	0.2
Probability of Annual Exceedance (p_probability_of_annual_exceedance):	0.01

Velocity and Pressure Profile

The Velocity and Pressure Profile section of the Wind Design Report provides the wind loading results associated with the properties of both the structure and the environment surrounding the site. The Velocity and Pressure Profile gives detailed information about the particular loading wind masses will exert on any structure in the vicinity of the site and in particular to those of similar structural composition as the PV Module Farm. To further emphasize the probabilistic design nature of wind loading design and assist further structural considerations, the Wind Loading Design Report provides a detailed Wind Rose Diagram associated with wind velocities across all 16 directions, developed assuming the calculated basic wind velocity and applying multiplication factors in each direction, dependent on directional wind patterns on the site.The coefficients, factors, and site parameters presented here are mostly derived or modelled on previously established intrinsic characteristics of the site and its design.Eurocode and the national annexes in various countries including the British Standard have provisions for derivation or modelling of the velocity-pressure profile parameters, however certain factors and coefficients are empirically obtained or derived from semi or quasi empirical datasets transformed into graphs, in those cases the graphs provided were transformed into data to train Linear Regression models to allow for the generalization of design parameters based on the known (intrinsic) ones (further information onthe particular ML algorithms, training, verification and testing datasets can be presented as supplemented material on request.

Fundamental Wind Velocity (V_b_0): 27.32 [m/s]

Basic Wind Velocity (V_b):	27.73 [m/s]
Mean Wind Velocity (V_m):	32.10 [m/s]
Exposure Coefficient (c_e)	1.16
Orography Coefficient (c_o_orograhpy):	1.00
Probability Factor (c_prob_factor):	1.02
Terrain Factor (k_r_terrain_factor):	0.16
Rougness Factor (c_r_roughness_factor):	1.16
Turbulence Factor (Iv_turbulence_factor):	0.16
Reference Mean Velocity Pressure (q_b):	471.48 [N/m^2]
Peak Velocity Pressure (q_p):	935.65 [N/m^2]
Total Wind Force per unit area (F_total):	935.65 [N/m^2]

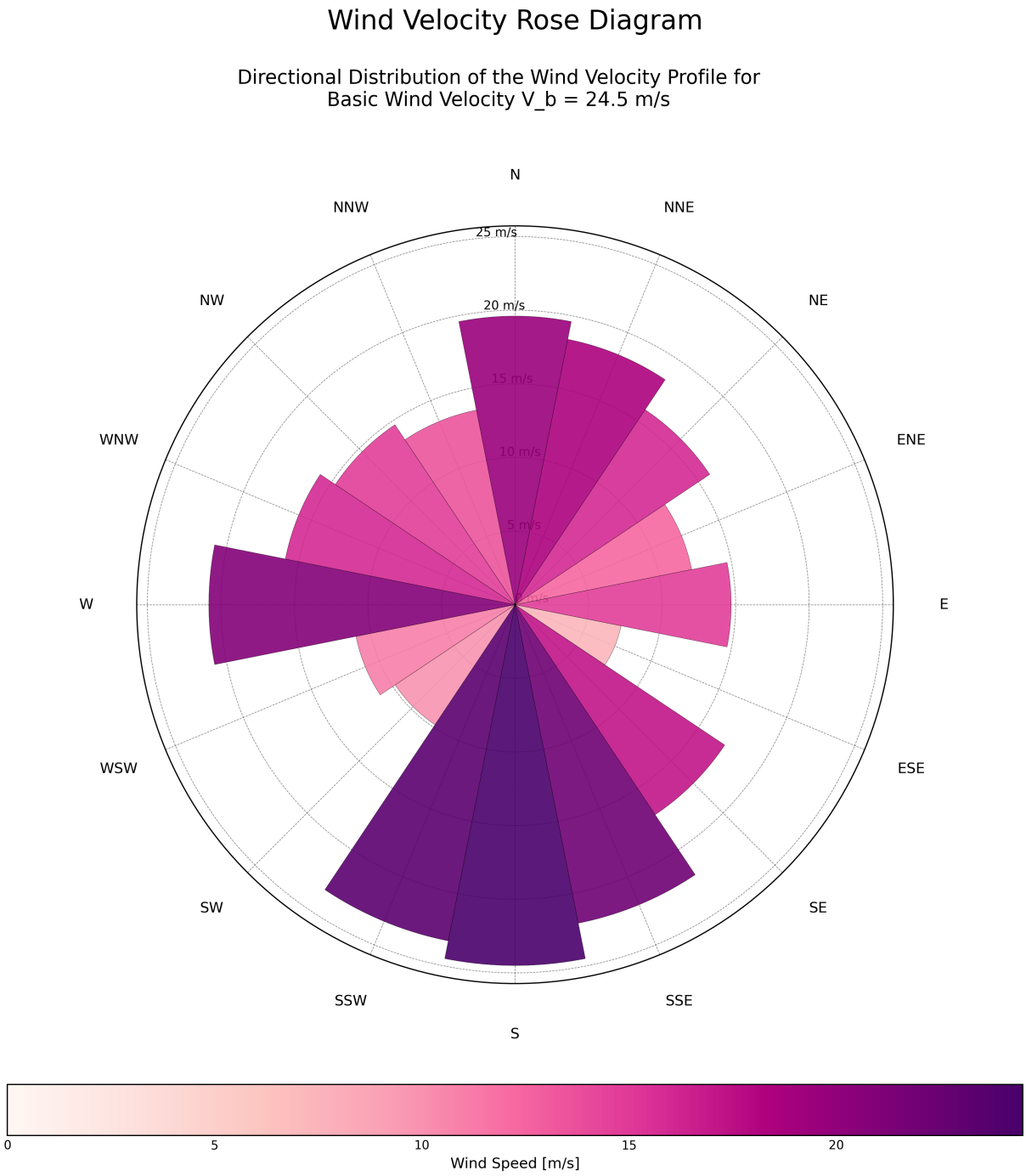
Static Loading

This section aims to establish the shear, moment, and uplift forces acting on the selected structure, which are influenced by the structure's geometry as well as site-specific wind velocity and pressure parameters.In the context of this Wind Loading Report, where the primary use case scenario involves a solar farm, the focus is on the forces exerted on the Module Mounting Structure (MMS) and its foundations. The static loadings can be understood as the forces acting on the piles or foundational supports (such as ballasts, helical or screw foundations, concrete counterweight foundations, or others). For the foundations, these forces can be viewed as axial forces acting on an individual pile in tension, compression, and horizontal (lateral) directions. The uplift force will exert tensile forces on the foundation piles, while the shear force will induce lateral loadings. The third pile-related force (compression) mainly results from the dead load of the system and is typically considered the least critical when verifying the MMS design against Pull Out Test results. These tests are an industry standard and the most widely used foundation design verification procedure, while alternatives exist these tests and their use case scenarios are widespread and therefore specifically chosen as the design method of choice.To summarize, the wind loading forces acting on the chosen design structure, defined by its geometry and the site location, can be categorized as follows:

Total Shear Force on the Structure:	10156.87 [N]
Total Bending Moment on the Structure:	25392.18 [Nm]
Total Uplift on the Structure:	7111.92 [N]

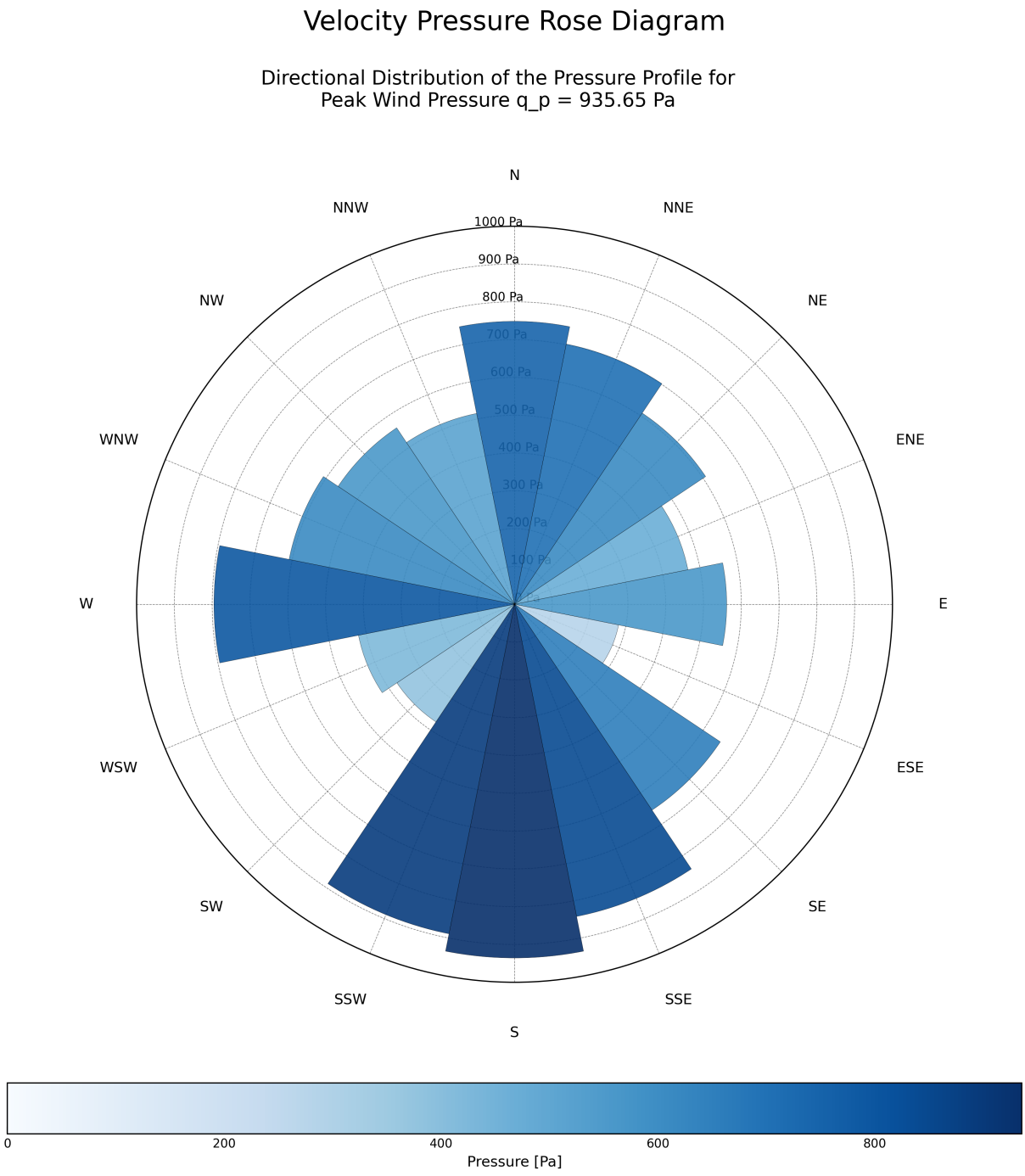
Wind Velocity Rose Diagram

This section provides the wind rose diagram indicating the directional distribution of wind velocity based on the given profile.The sixteen general directions indicated within the context of the drawing have their associatedwind velocity profile.



Velocity Pressure Rose Diagram

This section provides the pressure rose diagram indicating the directional distribution of wind velocity pressurebased on the given profile.



Conclusions

This report provides a comprehensive analysis of the wind loading on the EXAMPLE NAME Solar Farm. Based on the principles and guidelines of Eurocode 0 (EN 1990) and Eurocode 1 (EN 1991-1-4), the following important values have been derived:

1. Reference Mean Velocity Pressure (q_b): 471.48 N/m²
2. Peak Velocity Pressure (q_p): 935.65 N/m²
3. Total Wind Force per unit area (F_total): 935.65 N/m²

These values provide a robust basis for assessing the structural integrity and safety of the solar farm under wind loading conditions. By adhering to the Eurocode standards, this analysis ensures compliance with European structural design requirements, guaranteeing the reliability and resilience of the EXAMPLE NAME Solar PV Farm against wind actions.