ICC-SWCC™
SUMMARY REPORT SWCC-22-02

CERTIFICATION HOLDER: Kodair Wind Designs Ltd.
Cashla
Athenry, County Galway
Ireland H65 V243
www.kodairwind.com

MODEL: KW20

CERTIFICATION NUMBER: SWCC-22-02

The above-identified Small Wind Turbine was issued certification SWCC 22-02 under the ICC–SWCC Small Wind Turbine Certification Program to the ACP 101-1 – 2021, Small Wind Turbine Standard on February 20, 2025.

ICC-SWCC certifications are subject to annual review and renewal. To confirm current certification status and view the certificate of certification, visit: www.smallwindcertification.org.

This ICC-SWCC Summary Report is intended to augment the certification document by providing additional details on the test results for the KW20 that were evaluated for certification in accordance with the *ACP 101-1 – 2021, Small Wind Turbine Standard*. All field tests for certification were conducted at Kodair's site near Galway, Ireland from September 2023 to January 2024.

The KW20 is a 3-blade, upwind, horizontal axis wind turbine with a swept rotor area of 134.8 m^2 manufactured by Kodair Wind Designs, Ltd. The tested configuration had a single-phase, 240 VAC output and utilized an EL Power 30UL inverter. It was mounted atop a 20 m (65.6 ft) monopole-telescopic tower manufactured by Kodair.

Rotor Configuration:	Horizontal (HAWT)	Overspeed Control:	Active pitch with pull-back system
Number of Blades:	3	Yaw Configuration:	Active control, upwind
Rotor Diameter:	13.1 m	Pitch Control:	Variable
Rotor Swept Area:	134.8 m^2	Power Form:	240 VAC, 1-phase, 60 Hz
Cut-In Wind Speed:	3 m/s	Maximum Overcurrent Protection:	208 AC @ 240 VAC
Cut-Out Wind Speed:	25 m/s	Inverter:	ELPower 30UL

1. PERFORMANCE RATINGS

Standardized turbine performance ratings are determined from the laboratory test data in accordance with the methods in the ACP 101-1-2021 standard. Performance is quantified for the following parameters:

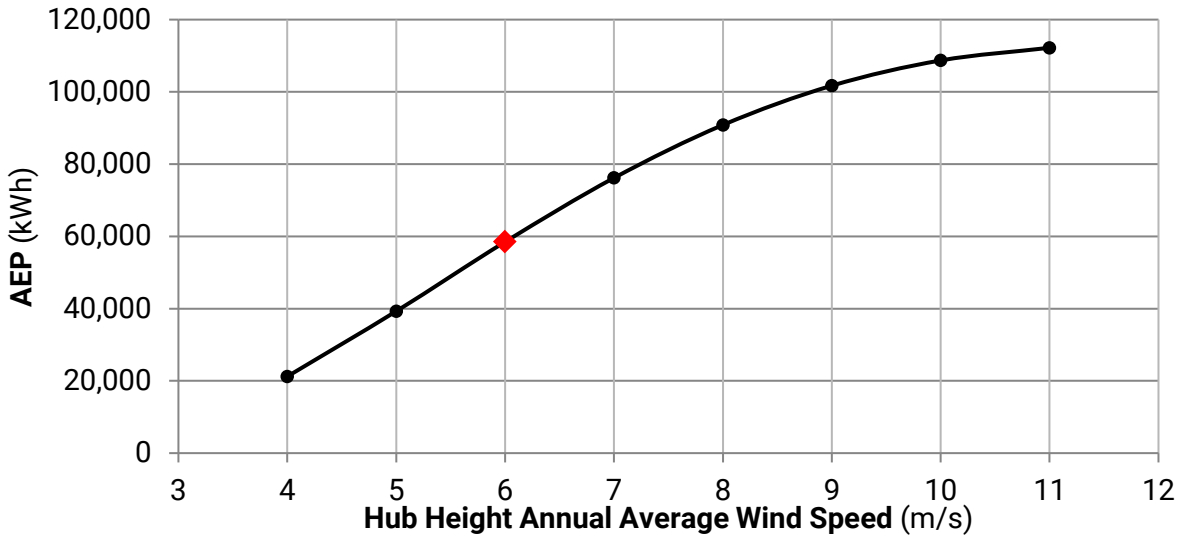
- Estimated Annual Energy Production
- Instantaneous Power Production
- Acoustic Sound Levels

ACP Ratings are provided at reference conditions defined in the standard to allow for comparison between certified turbines. This Summary Report provides performance values under additional conditions in tabular and graphical forms to facilitate product selection and system design. In all cases, actual performance will vary depending on site conditions for installed turbines.

Estimated Annual Energy Production

The ACP standard prescribes calculation of estimated annual energy production utilizing the power curve measured by means of power performance testing in the field per Section 2 and IEC 61400-12-1, ed. 2. The estimated annual energy production is calculated by applying a Rayleigh wind speed distribution to the power curve over one year and assuming 100% availability at sea level. Air density at sea level is assumed to be 1.225 kg/m^3.

The certificate, consumer label and this report display the Reference Annual Energy Production which is the AEP value at 6 m/s (13.4 mph), wind speed, for comparison between turbines. This report also provides a table and graph of annual energy production values over a range of annual average wind speeds at hub height as shown below. The ACP Reference Annual Energy Production is **58,805 kWh/year at a hub height wind speed of 6 m/s** and is highlighted in red below.



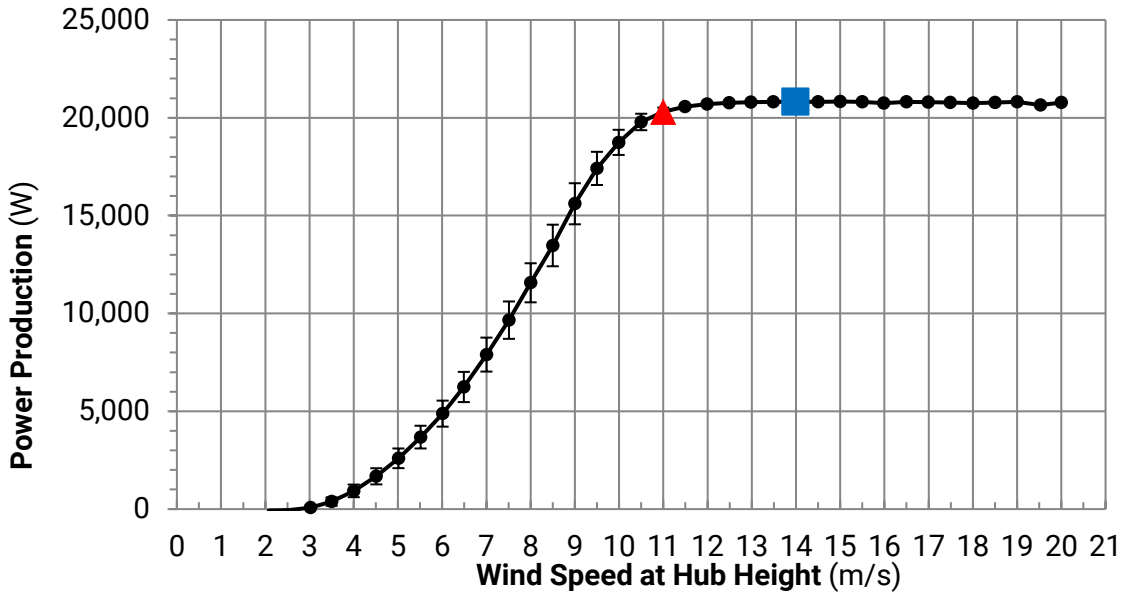
Annual Ave. Wind Speed at Hub Height (m/s)	AEP Measured (kWh)	Standard Uncertainty (kWh)	Standard Uncertainty (%)	AEP Extrapolated (kWh)
4	21,228	106	0.50%	21,228
5	39,282	155	0.40%	39,282
6	58,484	179	0.30%	**58,508**
7	76,182	178	0.20%	76,437
8	90,839	163	0.20%	91,969
9	101,710	143	0.10%	104,759
10	108,699	123	0.10%	114,722
11	112,198	105	0.10%	121,896

Power Production

The ACP standard establishes the methods for Power Performance Testing in Section 2 of the standard, which references IEC 61400-12-1, ed. 3 (including Annex H). The result of that testing is a measured power curve which is corrected to sea level conditions. This is shown as a function of wind speed at hub height, for the turbine below.

The certificate, consumer label and this report display the ACP Reference Power Production which is set by the standard at 11 m/s (24.6 mph) at sea-level. This report also provides a graph of the power production curve over a range of wind speeds at hub height as shown below. For this turbine, the ACP Reference Power Production is **20.3 kW at a hub height wind speed 11 m/s**, and is highlighted below with a red triangle.

The ACP Peak Power is defined as the highest binned power of the filled wind speed in the peak power range defined in Section 4.1.3. It is given at the Peak Power Wind Speed. For this turbine, the ACP Peak Power is **20.8 kW at a peak power wind speed of 14 m/s at hub height**. It is highlighted below with the blue square.



Corrected to a sea level air density of 1.225 kg/m³					**Category A**	**Category B**	**Combined**
Bin No.	**Hub Height Wind Speed**	**Power Output**	**Cp**	**1-minute samples**	**Standard Uncertainty, Si**	**Standard Uncertainty, Ui**	**Standard Uncertainty, Ci**
-	*m/s*	*W*	-	-	*W*	*W*	*W*
-	-	-	-	-	-	-	-
2.0	2.1	-75	-0.10	92	2.3	7.2	7.6
2.5	2.5	-56	-0.04	251	3.8	37.2	37.4
3.0	3.0	75	0.03	342	8.1	111.0	111.2
3.5	3.5	384	0.11	542	10.6	215.9	216.2
4.0	4.0	932	0.18	461	13.7	321.6	321.9
4.5	4.5	1677	0.22	376	19.2	412.6	413.0
5.0	5.0	2597	0.25	408	24.8	501.7	502.3
5.5	5.5	3681	0.27	545	32.2	579.7	580.6
6.0	6.0	4880	0.27	589	44.0	664.1	665.6
6.5	6.5	6242	0.28	670	47.0	771.3	772.7
7.0	7.0	7897	0.28	698	58.6	866.0	868.0
7.5	7.5	9658	0.28	742	60.6	953.2	955.1
8.0	8.0	11567	0.27	780	69.2	995.9	998.3
8.5	8.5	13474	0.27	798	75.9	1060.7	1063.4
9.0	9.0	15606	0.26	645	85.6	1046.0	1049.5
9.5	9.5	17413	0.25	569	87.1	843.4	847.8
10.0	10.0	18744	0.23	459	80.5	637.7	642.7
10.5	10.5	19786	0.21	397	73.5	413.9	420.3
11.0	11.0	**20300**	0.18	330	63.8	213.6	222.9
11.5	11.5	20567	0.16	274	42.3	113.8	121.4
12.0	12.0	20707	0.15	225	39.3	53.6	66.5
12.5	12.5	20761	0.13	172	27.2	27.8	38.9
13.0	13.0	20805	0.12	154	24.2	16.3	29.2
13.5	13.5	20818	0.10	139	21.8	5.6	22.5
14.0	14.0	**20825**	0.09	147	19.2	1.5	19.2
14.5	14.5	20818	0.08	122	19.1	1.7	19.2
15.0	15.0	20822	0.07	141	11.6	3.9	12.3
15.5	15.5	20806	0.07	127	9.6	21.1	23.2
16.0	16.0	20753	0.06	130	11.4	1.8	11.6
16.5	16.5	20807	0.06	123	7.0	15.2	16.8
17.0	17.0	20805	0.05	69	14.2	7.3	16.0
17.5	17.5	20784	0.05	67	20.7	18.8	28.0
18.0	18.0	20743	0.04	58	14.4	1.5	14.5
18.5	18.5	20781	0.04	33	18.6	20.5	27.7
19.0	19.0	20808	0.04	28	33.5	40.5	52.5
19.5	19.5	20646	0.03	22	22.3	4.4	22.7
20.0	20.0	20777	0.03	11	28.6	7.7	29.6

Acoustic Sound Levels

The ACP standard establishes the requirements for Acoustic Testing in Section 3 of the standard. The result of that testing, per IEC 61400-11, ed. 3 (including Annex F) is shown below.

The certificate, consumer label and this report display the ACP Reference Sound Pressure Level rating. This is defined as the sound level produced by the turbine that will not be exceeded 95% of the time, assuming 5 m/s (11.2 mph) annual average wind speed at hub-height, a Rayleigh wind speed distribution, 100% availability, at sea-level, observed 60 m (~200 ft) from the rotor center.

The test report submitted in support of the application for certification of the KW20 turbine contained insufficient acoustic data at several wind speeds, per IEC 61400-11, ed.3, Annex F. For the dataset provided to date, the ACP Reference Sound Pressure Level is **41.8 dB(A) at an annual average hub height wind speed of 5 m/s**. This value is subject to change and will be updated with a graph of the A-weighted apparent sound pressure level values will be provided when the full, compliant dataset is provided to SWCC.

2. QUALIFICATION TESTING AND EVALUATION

In addition to testing of the performance of the turbine, the ACP 101-1 standard requires that each turbine undergo testing to confirm the safety, functionality and durability of the turbine. Turbines also undergo an evaluations of the overall safety of structural and mechanical systems. These tests and evaluations do not result in ratings or metrics, but must be passed in order to achieve certification. Each is described briefly below.

DURATION TESTING

The Kodair KW20 successfully completed duration testing for an IEC Class II Small Wind Turbine in accordance with Section 6 of the standard. This references the testing method prescribed in IEC 61400-2 with modifications. The testing was performed from November 8, 2023 to January 1, 2024. The observed maximum 3-second wind gust recorded during the test was 40.5 m/s (90.6 mph). The 1-minute average temperature ranged from -2 to 14°C (28 to 57°F)during the duration testing. The average turbulence intensity at 15 m/s was 12.13%. The total power production time for the duration testing was 1078 hours, 22 h of which were categorized as high-wind hours (>15 m/s).

MECHANICAL STRENGTH ANALYSIS

The mechanical strength analyses conducted for the KW20 were evaluated by ICC-SWCC and found to be in conformance with IEC 61400-2 as modified by Section 5, ACP 101-1 – 2021 for an IEC Class II Small Wind Turbine. This includes loads analysis by means of aeroelastic modeling, validated against measured data.

SAFETY AND FUNCTION TESTING

Safety and Function testing was found to be in conformance with Section 4, ACP 101-1 – 2021. This includes verification of the function of critical control and protection system functions and power limitation.

3. TOWER DESIGN REQUIREMENTS

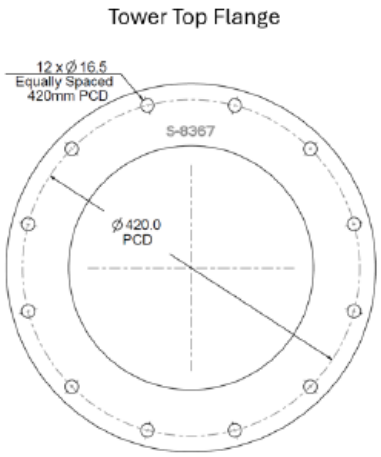
Turbine towers and foundations are excluded from the scope of ACP 101-1, per Section 1.3.3. However, the standard requires the reporting of key design requirements for the towers to be used with the turbine, as specified by the turbine manufacturer, per Section 5.6. Towers selected for turbines must comply with all current specifications and requirements of the turbine manufacturer and local codes and regulations.

All testing conducted per ACP 101-1 was conducted for the KW20 mounted atop a 20 m, galvanized steel, 18-sided, slip-joint-monopole, tilt-up tower manufactured by Kodair.

Disclaimer: These design requirements are provided below, as reported by the manufacturer. ICC-SWCC has not independently verified or evaluated these values and is not responsible for any errors or omissions.

Mechanical and Electrical Connections

The turbine is attached to the tower by means of a bolted flange with (12) M16 x 70mm bolts with M16 wedge washers and M16 lock nuts. The bolts are equally spaced around the flange at a 420 mm diameter.

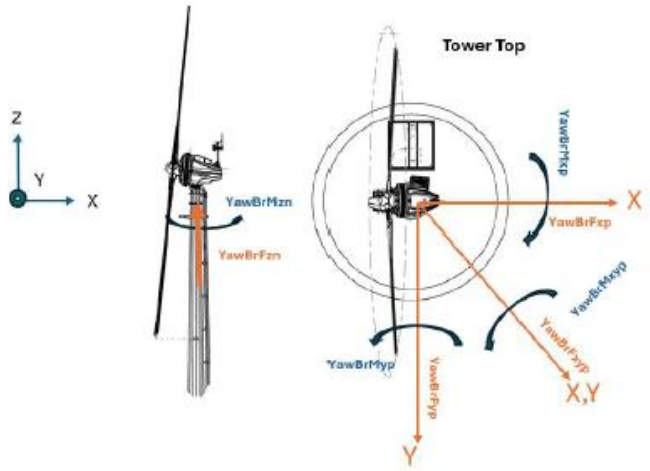


Electrical connections consist of a signal cable, power cables and ground wire passing within the tower into the nacelle through the center of the bolted flange. Power connectors are affixed to a tower end cap. The ground wire is affixed to a ground connection on the nacelle of the turbine by means of a M8x30 mm screw and lug. The signal cable is joined by means of a free connector passing through a slot in in the tower end cap.

Maximum Tower-Top Loads

The maximum tower-top loads, with a 1.35 safety factor, are given below:

YawBrFxp	1,830 N
YawBrFyp	8,420 N
YawBrFzn	-26,100 N
YawBrFxyp	8,610 N
YawBrMxp	-955 N
YawBrMyp	-42,300 N
YawBrMzn	-9,300 N
YawBrMxyp	42,300 N



Minimum Blade/Tower Clearance

No-load blade to tower clearance should be less than or equal to 1.23 m.

Maximum Tower Top Deflection

The maximum tower-top deflection is 1% of the tower height. For the 20 m hub-height used for certification testing, the tower-top height was 19.2 m, resulting in a maximum deflection of 192 mm.

Fundamental Frequencies to Avoid

The fundamental frequencies to avoid were determined by means of OpenFAST aeroelastic analysis and are reported below along with the associated mode. The manufacturer indicates that the rotational operating speed range is 0 to 73 RPM under normal operating conditions.

Tower Mode	**Natural Frequency** *(Hz). (no ice)*
1	1.4
2	8.4

The Campbell Diagram for the turbine and tower combination was determined by means of OpenFAST simulations and is given below.