REPORTE BIMESTRAL DE CAMPAÑA DE MEDICIÓN

TORRE ECH1

PARQUE EÓLICO CHINAMPAS, GRUPO DRAGÓN

11 DE ENERO DE 2018

Índice

1 DESCRIPCIÓN DEL PROYECTO

Las ubicación del mástil es en el municipio de Ojuelos de Jalisco, Jalisco, México, su ubicación en coordenadas UTM WGS84 de la torre de medición anemométrica puede verse en la siguiente tabla:

ECH1			
País	México	**Estado**	Jalisco
Zona UTM	14 Q	**Sistema de posicionamiento**	UTM WGS84
Este	217278	**Norte**	2401931
Altura sobre el nivel del mar (m)	2607	**Altura del mástil de medición**	2015-20170501:49.5m 20170508-actual:94m
Inicio de mediciones	07/2012-07/2015 09/06/2015-07/05/2017 **08/05/2017 (campaña actual)**	**Último dato revisado**	23/01/2018
Configuración de tiempo	UTC -6 hrs	**Código de proyecto**	DG171502

Tabla 1. Ubicación de mástil de medición

Figura 1.

La estación de medición anemométrica se sitúa en el estado de Jalisco, a aproximadamente 60km al sureste de Aguascalientes, Aguascalientes y 60km al norte de León, Guanajuato alrededor de la torre de medición podemos ver vegetación alta que prevalece por árboles

mayores a 5m, ya que se encuentra en la parte más alta de una colina los sensores pueden presentar interferencia de este tipo de vegetación,

En cualquiera de los puntos cardinales que nos ubiquemos encontraremos pendientes pronunciadas, ya en la parte baja del proyecto podemos encontrar pastizales y algunos cactus.

No hay obstrucciones construidas como casas o molinos de viento para extracción de agua cercano al punto de medición, la comunidad de Vaquerias es el área habitada más cercana al proyecto.

El sitio tiene un modelo de lluvia GPCC (16), un valor a largo plazo de 440 mm/año, clasificando el clima por Köppen- Geiger como BSk: frío y árido clima de estepa.

2 BITÁCORA DE LA CAMPAÑA DE MEDICIÓN Y VISITAS A SITIO

2.1 Descripción

La torre arriostrada TZ45 ECH1 es una estructura triangular que por su fabricación y diseño es recomendable para zonas con vientos de hasta 200 km/hr. El rango de altura para este modelo es desde 80m a 105 m.

Por su versatilidad estructural y facilidad de montaje, esta torre es apta para sistemas de medición de recurso eólico.

La campaña de medición de ECH1 ha pasado distintas etapas siendo modificada recientemente pasando de 58m a 94m, rehabilitando algunos tramos y soportes ya instalados en la torre.

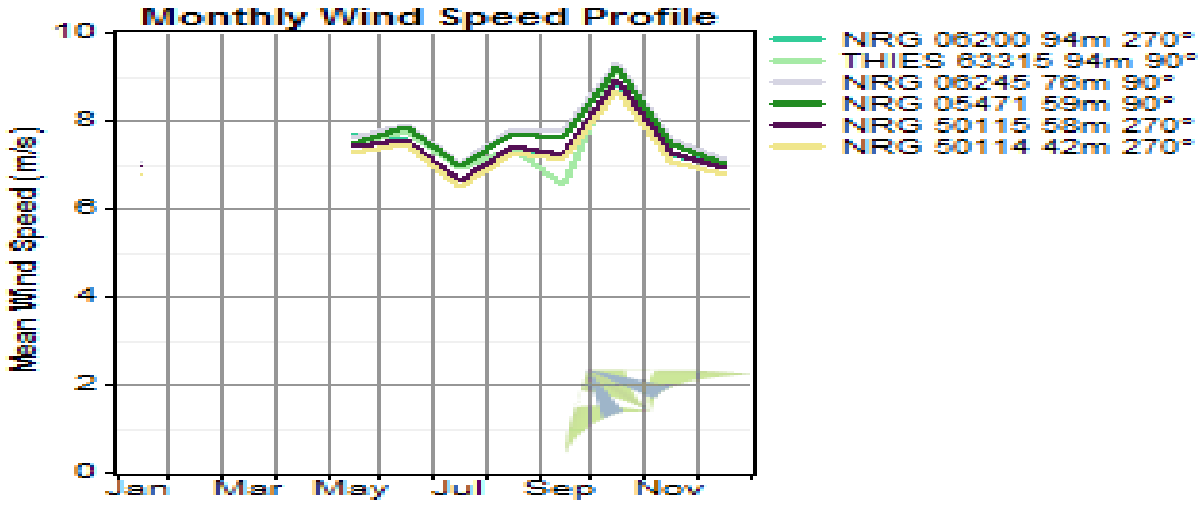
Logbook WM ECH19202			
Descripción	Fecha	Actividades	Editor
Inicio de trabajos en torre de medicón , valoración de equipos y condiciones de la estación.		Visita de inspección a torre ECH1, verificación de anclajes, retenidas, equipos y sensores de medición	LAM
Instalación de torre de medición Reconfiguración de torre de medición en Vaquerías PE Chinampas Juan Carlos Valdivieso (HW) Gabriel Valdivieso (HW) Luis Ángel Martínez (LW) Fortunado Alcalá (FW) Oswaldo López (FW)	2017/05/07	Inicio de campaña de medición Coordenadas de la torre y orientación de sensores: UTM WGS 84 14Q: 0217278 E, 2401921N Elevation: 2558 m Orientación de Soportes magnética: Anemómetros 94m: 95º/ 270° 76m: 90°60m: 270º/90° 42m:270° Veleta 1(92m): 270° Veleta 2 (72m):270° Queda pendiente la configuración del iPack, no hay acceso durante la visita.	LAM
Visita de configuración iPack	2017/05/17	Se propone cambio de SIM para establecer comunicación remota.	LAM
Instalación de luz de obstrucción y mantenimiento correctivo en veleta de ch8 92m	2017/09/08	Mantenimiento correctivo en veleta 92m, instalación de balizamiento nocturno a 94m.	LAM
Correctivo en iPack y cambio de cable de tierra	2017/09/11	Cambio de tarjeta SIM SIM Telcel 89520206172613846 9 NT: 4775212194 Password: telenerdragon Cambio de cable de tierra por calibre 1/0	LAM
Correctivo en iPack	2017/09/27	Cambio de iPack GSM SN:798400674	LAM
Descarga de datos	2017/12/01	Descarga de datos en sitio	LAM

2.2 ECH1

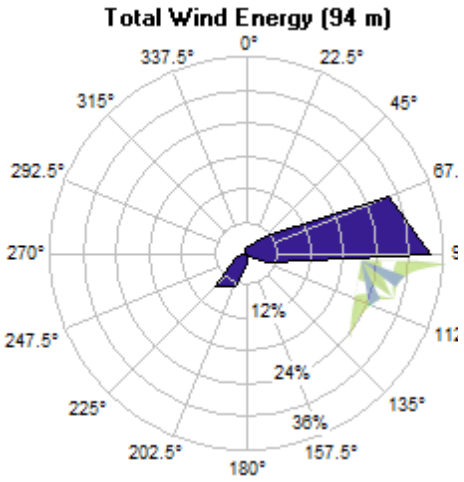
3 RESULTADOS DE LA CAMPAÑA DE MEDICIÓN.

Variable	Value
Latitude	N 21° 41' 54.000"
Longitude	W 101° 43' 57.000"
Elevation	2607 m
Start date	08/05/2017 00:00
End date	22/01/2018 00:00
Duration	8.5 months
Length of time step	10 minutes
Calm threshold	0 m/s
Mean temperature	13.7 °C
Mean pressure	71.43 kPa
Mean air density	0.866 kg/m³
Power density at 50m	301 W/m²
Wind power class	3 (Fair)
Power law exponent	0.0443
Surface roughness	0.00000000818 m
Roughness class	0.00
Roughness description	Smooth

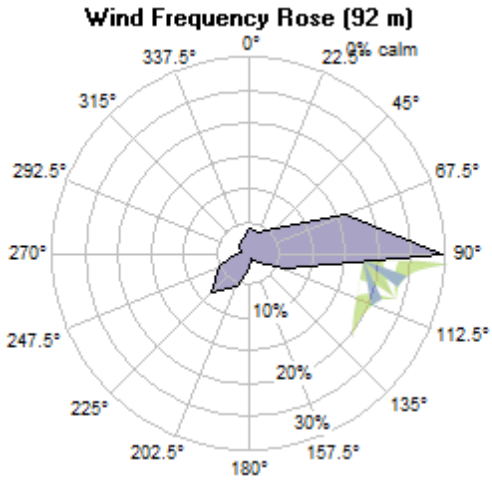
3.1 Promedio de velocidad de viento por mes.



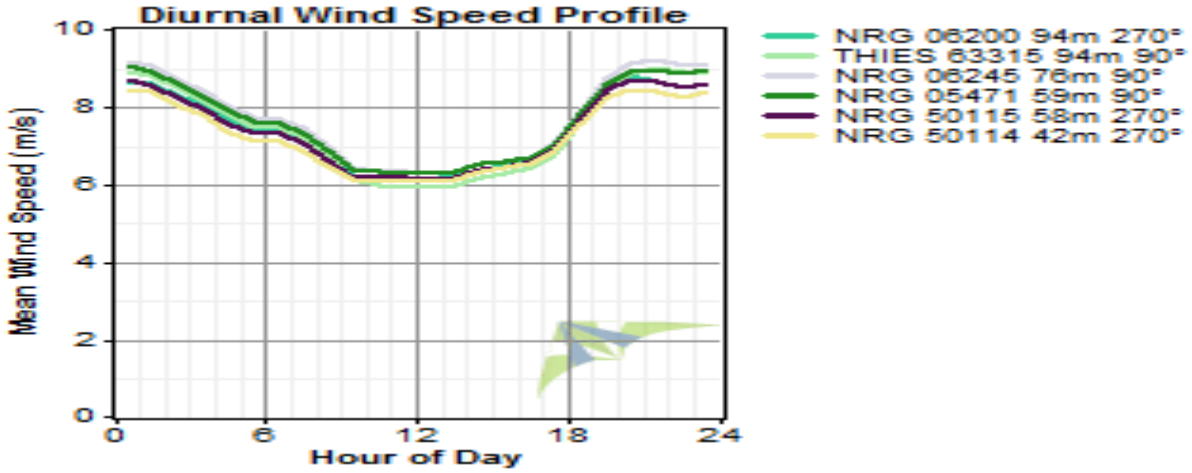
3.1.1.1 Rosa de energía



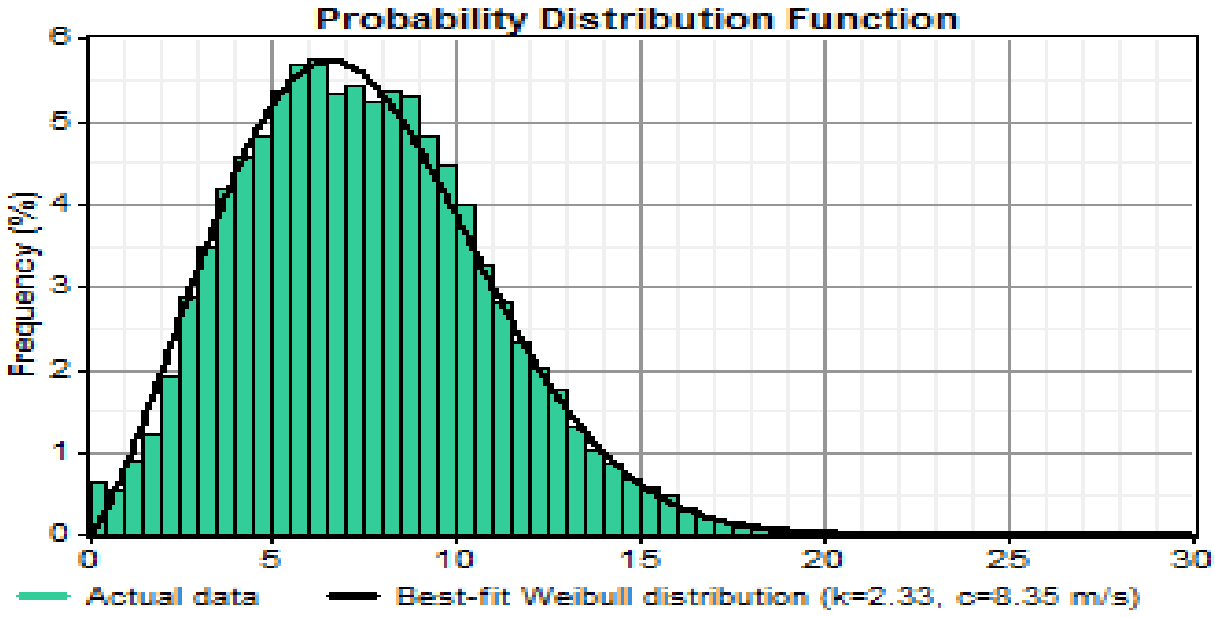
3.1.1.2 Rosa de frecuencia Veleta 92m.



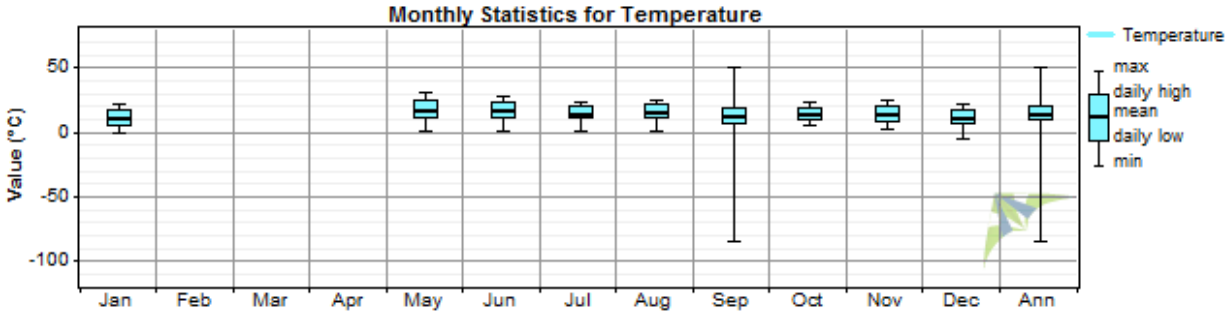
3.1.1.3 Per fil de viento diurno.



3.1.1.4 Distribución de la función de probabilidad.



3.1.1.5 Temperatura promedio.



4 CAMPAÑA DE MEDICIÓN ECH1.

ECH1			
Inicio de mediciones: 2017/05/08		Último dato considerado para el reporte 2017/12/01	
Promedio de velocidad de viento	CH1 58m: 7.39 m/s CH2 42m: 7.23 m/s CH3 94m: 7.41 m/s CH4 94m: 7.44 m/s CH13 76m: 7.72 m/s CH14 59m: 7.62 m/s	Datos viables	CH1 58m: 97.57% CH2 42m: 97.57% CH3 94m: 97.57% CH4 94m: 97.57% CH13 76m: 97.57% CH14 59m: 97.57%
Temperatura promedio	13.69°C	Presión atmosférica promedio	71.43 kPa
Dato mínimo promedio de velocidad de viento	0 m/s	Máximo promedio de velocidad de viento	NRG 50114 42m CH2: 32.10 m/s
Otras estaciones cercanas	ECH2 4km		

Data Set Properties

Report Created: 12/02/2018 18:26 using Windographer 2.0.1
Filter Settings: <Unflagged data>

Variable	Value
Latitude	N 21° 41' 54.000"
Longitude	W 101° 43' 57.000"
Elevation	2607 m
Start date	08/05/2017 00:00
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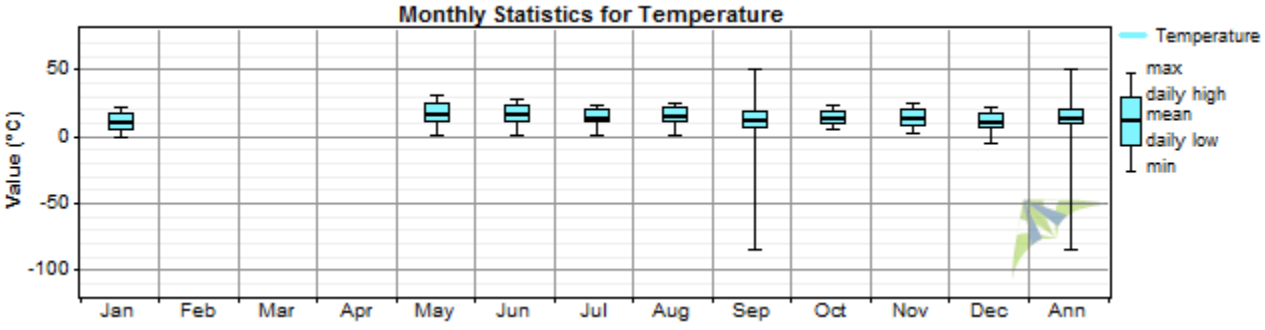


Data Column Properties

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
Date & Time Stamp			37,296	37,236	99.84	15.73	1.00	31.00	8.65
Date	days		37,296	37,236	99.84	90	1	2,018	398
DATA VALID	day		37,296	36,390	97.57	1,996	0	2,018	198
NRG 50115 58m 270°	m/s	58 m	37,296	36,390	97.57	7.39	0.10	22.50	3.38
NRG 50115 58m 270° SD	m/s		37,296	37,236	99.84	1.06	0.00	17.20	1.71
NRG 50115 58m 270° Max	m/s		37,296	37,236	99.84	9.09	0.40	27.50	3.69
NRG 50115 58m 270° Min	m/s		37,296	37,236	99.84	5.61	0.40	17.20	3.17
NRG 50114 42m 270°	m/s	42 m	37,296	36,390	97.57	7.23	0.10	21.80	3.28
NRG 50114 42m 270° SD	m/s		37,296	37,236	99.84	1.11	0.00	18.30	1.69
NRG 50114 42m 270° Max	m/s		37,296	37,236	99.84	9.06	0.40	32.10	3.72
NRG 50114 42m 270° Min	m/s		37,296	37,236	99.84	5.34	0.20	16.80	2.96
NRG 06200 94m 270°	m/s	94 m	37,296	36,390	97.57	7.41	0.10	25.50	3.35
NRG 06200 94m 270° SD	m/s		37,296	37,236	99.84	1.02	0.00	16.70	1.71
NRG 06200 94m 270° Max	m/s		37,296	37,236	99.84	9.04	0.20	28.90	3.64
NRG 06200 94m 270° Min	m/s		37,296	37,236	99.84	5.75	0.20	22.40	3.21
THIES 63315 94m 90°	m/s	94 m	37,296	36,390	97.57	7.44	0.10	25.30	3.76
THIES 63315 94m 90° SD	m/s		37,296	37,236	99.84	0.87	0.00	16.70	1.63
THIES 63315 94m 90° Min	m/s		37,296	37,236	99.84	6.79	0.30	22.40	4.06
Direction 72 m	°	72 m	37,296	11,463	30.74	8.7	0.3	359.0	29.5
Direction 72 m Max	°		37,296	36,600	98.13	124.3	0.0	359.0	81.5
Direction 72 m Min	°		37,296	36,600	98.13	7.8	0.0	117.0	9.6
Direction 72 add	°		37,296	36,600	98.13	0	0	0	0
Direction 72 m SD	°		37,296	36,600	98.13	2.8	0.0	358.0	23.9
Direction 92 m	°	92 m	37,296	36,600	98.13	86.8	0.0	359.0	90.0
Direction 92 m Min	°		37,296	36,600	98.13	7.5	0.0	122.0	12.5
Direction 92 m add	°		37,296	36,600	98.13	0	0	0	0
Temperature	°C		37,296	37,236	99.84	0.59	-86.40	27.90	3.46
Temperature	°C		37,296	37,236	99.84	13.69	-86.10	49.20	5.55
Temperature SD	°C		37,296	37,236	99.84	0.73	-86.20	51.40	3.51
Temperature Min	°C		37,296	37,236	99.84	14.54	-86.40	34.30	5.26
Temperature Max	°C		37,296	37,236	99.84	16.53	-86.40	75.00	12.81
BP20 31625 12m kPa	kPa		37,296	37,236	99.84	71.43	0.00	75.30	14.81
BP20 31625 12m kPa SD	kPa		37,296	37,236	99.84	3.04	0.00	75.00	14.69
BP20 31625 12m kPa Max	m/s		37,296	37,236	99.84	74.5	65.1	108.6	1.5
BP20 31625 12m kPa Min	Volt		37,296	37,236	99.84	71.87	0.00	75.30	12.53
VOLTMETER V	Volt		37,296	37,236	99.84	11.66	0.00	14.60	3.17
VOLTMETER V Max	Volt		37,296	37,236	99.84	0.49	0.00	14.80	2.39
VOLTMETER V Min	m/s		37,296	37,236	99.84	12.17	0.00	15.00	2.14
NRG 06245 76m 90°	m/s		37,296	37,236	99.84	11.90	0.00	15.40	2.41
NRG 06245 76m 90°	m/s	76 m	37,296	36,390	97.57	7.72	0.10	24.40	3.60
NRG 06245 76m 90° SD	m/s		37,296	37,236	99.84	0.70	0.00	12.50	0.71
NRG 06245 76m 90° Max	m/s		37,296	37,236	99.84	9.32	0.30	28.50	3.69
NRG 05471 76m 90°Min	m/s		37,296	36,390	97.57	6.16	0.30	18.60	3.57
NRG 05471 59m 90°	m/s	59 m	37,296	36,390	97.57	7.62	0.10	22.50	3.52
NRG 05471 59m 90° SD	m/s		37,296	37,236	99.84	0.72	0.00	12.50	0.72
NRG 05471 59m 90° MAX	m/s		37,296	36,390	97.57	9.29	0.20	28.90	3.67
NRG 05471 59m 90° Min	m/s		37,296	37,236	99.84	5.91	0.20	18.20	3.48
Speed SD	m/s		37,296	19,065	51.12	0.384	0.000	0.400	0.079

Label	Units	Height	Possible Records	Valid Records	Recovery Rate (%)	Mean	Min	Max	Std. Dev
Speed Max	m/s		37,296	19,065	51.12	0.016	0.000	0.400	0.079
Speed Min	m/s		37,296	19,065	51.12	0.3999	0.4000	0.4000	0.0001
NRG 50115 58m 270°	m/s		37,296	1,164	3.12	7.14	0.40	15.60	2.80
NRG 50115 58m 270° SD	m/s		37,296	1,164	3.12	0.805	0.000	2.700	0.470
NRG 50114 42m 270° SD	m/s		37,296	1,164	3.12	0.849	0.000	2.600	0.457
NRG 06200 94m 270° SD	m/s		37,296	1,164	3.12	0.748	0.000	2.700	0.444
THIES 63315 94m 90° SD	m/s		37,296	1,164	3.12	0.663	0.000	2.600	0.487
Direction 72 m	°		37,296	366	0.98	150.7	0.0	359.0	98.1
NRG 06245 76m 90° Min	m/s		37,296	1,164	3.12	5.59	0.30	15.10	3.07
NRG 05471 59m 90°	m/s		37,296	1,164	3.12	7.31	0.20	15.60	2.84
NRG 05471 59m 90° Max	m/s		37,296	1,164	3.12	9.19	0.20	17.40	3.03
Speed	m/s		37,296	366	0.98	0.4	0.4	0.4	0.0
Direction 72 m A	°		37,296	798	2.14	135.1	4.0	356.0	82.5
Direction 72 m A SD	°		37,296	798	2.14	9.77	0.00	69.00	9.33
Direction 72 m A Max	°		37,296	798	2.14	0	0	0	0
Direction 72 m A Min	°		37,296	798	2.14	0	0	0	0
Direction 72 m B	°		37,296	798	2.14	142.5	0.0	359.0	84.0
Direction 72 m B SD	°		37,296	798	2.14	8.51	0.00	98.00	10.70
Direction 72 m B Max	°		37,296	798	2.14	0	0	0	0
Direction 72 m B Min	°		37,296	798	2.14	0	0	0	0
Air Density	kg/m³		37,296	37,296	100.00	0.866	0.000	1.356	0.180
NRG 06200 94m 270° TI			37,296	36,390	97.57	0.29	0.00	67.00	2.00
THIES 63315 94m 90° TI			37,296	36,390	97.57	0.3	0.0	101.0	2.9
NRG 06245 76m 90° TI			37,296	36,390	97.57	0.27	0.00	52.50	1.93
NRG 05471 59m 90° TI			37,296	36,390	97.57	0.27	0.00	52.00	1.93
NRG 50115 58m 270° TI			37,296	36,390	97.57	0.29	0.00	61.00	1.84
NRG 50114 42m 270° TI			37,296	36,390	97.57	0.28	0.00	65.00	1.69
NRG 06200 94m 270° WPD	W/m²		37,296	36,390	97.57	301	0	7,641	395
THIES 63315 94m 90° WPD	W/m²		37,296	36,390	97.57	336	0	7,463	455
NRG 06245 76m 90° WPD	W/m²		37,296	36,390	97.57	349	0	6,694	451
NRG 05471 59m 90° WPD	W/m²		37,296	36,390	97.57	332	0	5,249	426
NRG 50115 58m 270° WPD	W/m²		37,296	36,390	97.57	300	0	5,249	384
NRG 50114 42m 270° WPD	W/m²		37,296	36,390	97.57	280	0	4,705	360

5 CONCLUSIÓN

El presente informe enmarca las actividades realizadas para el cumplimiento del contrato que enmarca el suministro, instalación y puesta en marcha de 2 torres meteorológicas z45 de 94m de altura.

Sin más por el momento, quedo a sus finas atenciones.

ATENTAMENTE,

RAFAEL ORDOÑEZ SEGURA
DIRECTOR GENERAL
TELENER 360, SA DE CV

6 ANEXOS

6.1 CERTIFICADOS DE CALIBRACIÓN

SOH Wind Engineering LLC

141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 17.US1.01093 **Date of issue:** January 30, 2017

Type: Thies 4.3351.10.000 **Serial number:** 09163315

Manufacturer: Thies Clima, ADOLF THIES GmbH & Co.KG, Hauptstrasse 76, 37083 Göttingen, Germany ,

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: January 27, 2017 **Anemometer calibrated:** January 30, 2017

Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.04607 · f [Hz] + 0.26649

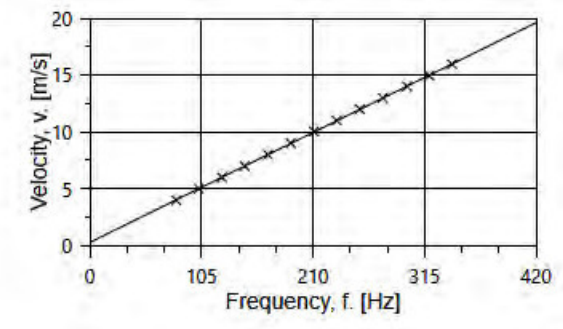
Standard uncertainty, slope: 0.00195 **Standard uncertainty, offset:** 0.07636

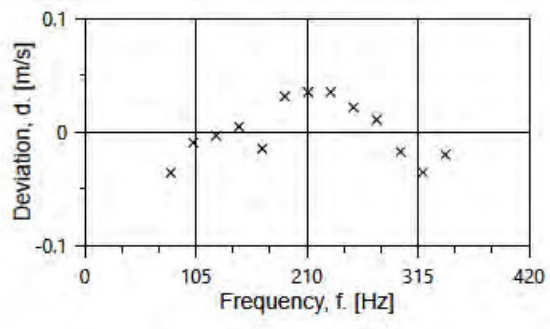
Covariance: -0.0000017 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999979

Absolute maximum deviation: -0.036 m/s at 3.976 m/s

Barometric pressure: 993.7 hPa **Relative humidity:** 17.5%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.26	21.8	25.7	3.976	81.3026	-0.036	0.025
4	14.55	21.9	25.7	4.984	102.6205	-0.010	0.026
6	21.04	21.9	25.7	5.992	124.3675	-0.003	0.027
8	28.60	21.9	25.7	6.987	145.7783	0.005	0.030
10	37.30	21.8	25.7	7.979	167.7247	-0.015	0.033
12	47.57	21.8	25.7	9.011	189.1299	0.031	0.036
13-last	58.83	21.8	25.7	10.020	210.9606	0.035	0.039
11	70.97	21.8	25.7	11.007	232.3769	0.035	0.042
9	84.22	21.8	25.7	11.991	254.0318	0.021	0.045
7	98.75	21.9	25.7	12.985	275.8540	0.011	0.048
5	114.77	21.9	25.7	14.000	298.4978	-0.018	0.051
3	130.91	21.8	25.7	14.953	319.5640	-0.036	0.054
1-first	149.04	21.8	25.7	15.954	340.9526	-0.020	0.057





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.003
2254	Control cup anemometer
-	Mounting tube, D = 33.5 mm
TT004	Summit Electronics 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP006	Setra Model 239, 0-1inWC, differential pressure transducer
HY001	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP001	Setra Model 278, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

(none)

Certificate number: 17.US1.01093

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141 Leroy Road · Williston, VT 05495 · USA

Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 16.US2.15655 **Date of issue:** December 15, 2016

Type: RNRG Class 1 Anemometer **Serial number:** 596600005471

Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received: December 14, 2016 **Anemometer calibrated:** December 15, 2016

Calibrated by: SMR **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F

Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.76390 · f [Hz] + 0.23535

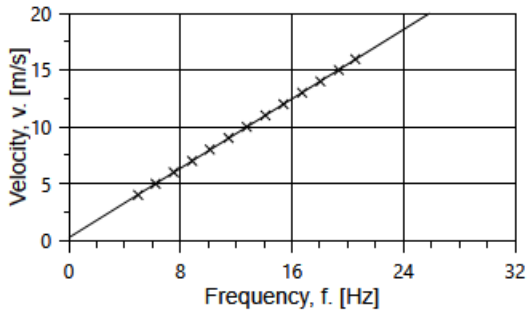
Standard uncertainty, slope: 0.00194 **Standard uncertainty, offset:** 0.08595

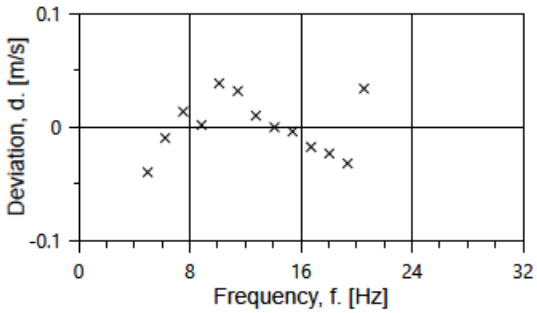
Covariance: -0.0000279 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999979

Absolute maximum deviation: -0.040 m/s at 3.992 m/s

Barometric pressure: 990.8 hPa **Relative humidity:** 13.7%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.24	24.1	26.5	3.992	4.9695	-0.040	0.024
4	14.38	24.2	26.5	4.981	6.2254	-0.010	0.025
6	20.83	24.2	26.5	5.993	7.5202	0.013	0.027
8	28.37	24.1	26.5	6.995	8.8463	0.002	0.030
10	37.07	24.1	26.5	7.996	10.1098	0.038	0.033
12	47.15	24.1	26.5	9.018	11.4558	0.032	0.036
13-last	57.90	24.1	26.5	9.993	12.7610	0.010	0.039
11	70.19	24.1	26.5	11.003	14.0963	0.000	0.042
9	83.38	24.1	26.5	11.994	15.3982	-0.004	0.045
7	97.97	24.1	26.5	13.001	16.7347	-0.018	0.048
5	113.52	24.1	26.5	13.996	18.0444	-0.024	0.051
3	130.33	24.1	26.5	14.997	19.3657	-0.032	0.054
1-first	147.64	24.1	26.5	15.960	20.5412	0.034	0.057





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EQUIPMENT USED

Serial Number	Description
Njord2	Wind tunnel, blockage factor = 1.0017
13924	Control cup anemometer
-	Mounting tube, D = 12.7 mm
TT001	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP007	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
66GSPS1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

(none)

Certificate number: 16.US2.15655

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

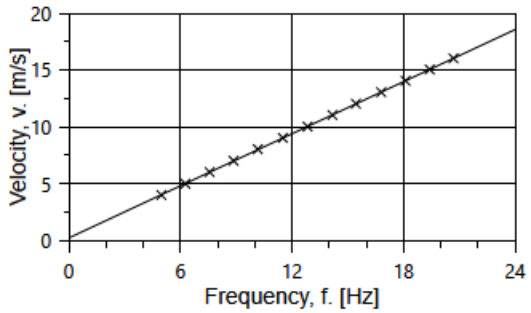
CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

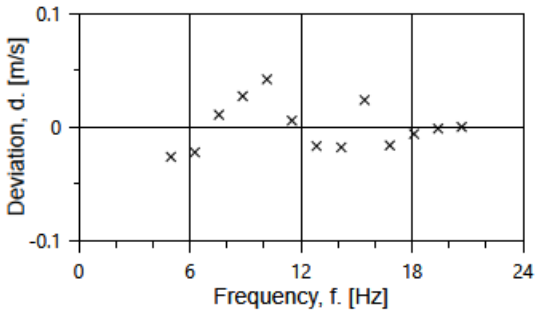
Certificate number: 17.US2.03434 **Date of issue:** March 27, 2017
Type: RNRG Class 1 Anemometer **Serial number:** 596600006200
Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Anemometer received: March 24, 2017 **Anemometer calibrated:** March 26, 2017
Calibrated by: SMR **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.76466 · f [Hz] + 0.21069

Standard uncertainty, slope: 0.00162 **Standard uncertainty, offset:** 0.08079
Covariance: -0.0000197 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999986
Absolute maximum deviation: 0.042 m/s at 8.026 m/s
Barometric pressure: 1013.3 hPa **Relative humidity:** 13.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.49	23.1	26.6	3.993	4.9808	-0.026	0.024
4	14.78	23.1	26.6	4.983	6.2709	-0.022	0.025
6	21.50	23.1	26.6	6.011	7.5710	0.011	0.027
8	29.26	23.1	26.6	7.012	8.8594	0.027	0.030
10	38.33	23.1	26.6	8.026	10.1654	0.042	0.033
12	48.42	23.1	26.6	9.021	11.5148	0.005	0.036
13-last	59.68	23.1	26.6	10.015	12.8442	-0.017	0.039
11	72.47	23.1	26.6	11.037	14.1814	-0.018	0.042
9	86.23	23.1	26.6	12.039	15.4381	0.023	0.045
7	101.23	23.1	26.6	13.045	16.8053	-0.016	0.048
5	117.48	23.1	26.6	14.053	18.1111	-0.006	0.051
3	134.74	23.1	26.6	15.050	19.4086	-0.002	0.055
1-first	152.86	23.0	26.6	16.029	20.6874	0.000	0.058





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EQUIPMENT USED

Serial Number	Description
Njord2	Wind tunnel, blockage factor = 1.0017
13924	Control cup anemometer
-	Mounting tube, D = 12.7 mm
TT001	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP008	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
66GSPS1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

(none)

Certificate number: 17.US2.03434

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

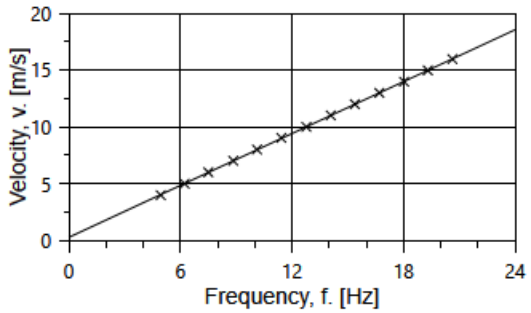
CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

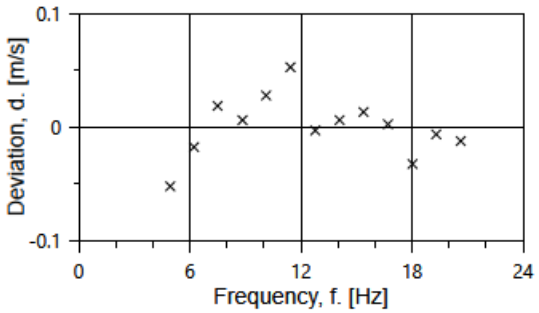
Certificate number: 17.US1.03217 **Date of issue:** April 03, 2017
Type: RNRG Class 1 Anemometer **Serial number:** 596600006245
Manufacturer: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: Renewable NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Anemometer received: March 28, 2017 **Anemometer calibrated:** March 29, 2017
Calibrated by: SMR **Procedure:** MEASNET, IEC 61400-12-1:2005(E) Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.76188 · f [Hz] + 0.26164

Standard uncertainty, slope: 0.00206 **Standard uncertainty, offset:** 0.08202
Covariance: -0.0000314 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999977
Absolute maximum deviation: 0.053 m/s at 9.025 m/s
Barometric pressure: 1010.8 hPa **Relative humidity:** 21.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.34	24.1	26.7	3.974	4.9421	-0.052	0.024
4	14.70	24.1	26.7	4.988	6.2271	-0.018	0.025
6	21.24	24.1	26.7	5.995	7.5005	0.018	0.027
8	29.02	24.1	26.7	7.007	8.8460	0.006	0.029
10	37.81	24.1	26.7	7.999	10.1195	0.028	0.032
12	48.14	24.1	26.8	9.025	11.4339	0.053	0.035
13-last	59.02	24.1	26.8	9.993	12.7776	-0.003	0.038
11	71.54	24.1	26.7	11.003	14.0905	0.006	0.041
9	85.01	24.1	26.8	11.995	15.3835	0.013	0.044
7	99.67	24.1	26.7	12.989	16.7019	0.002	0.047
5	115.23	24.1	26.7	13.966	18.0307	-0.033	0.050
3	132.32	24.1	26.7	14.966	19.3092	-0.007	0.053
1-first	150.65	24.1	26.7	15.969	20.6331	-0.013	0.056





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EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0017
2254	Control cup anemometer
-	Mounting tube, D = 12.7 mm
TT004	Summit Electronics 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP004	Setra Model 239, 0-1inWC, differential pressure transducer
HY001	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP001	Setra Model 278, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

(none)

Certificate number: 17.US1.03217

Certificate of Calibration

Renewable NRG Systems BP20 Barometric Pressure Sensor

Serial No. 1805 31325

Product Description:

Manufacturer	Description	Cal. Date
Renewable NRG Systems	BP20 Barometric Pressure Sensor	3/8/2017

Renewable NRG Systems, hereby certifies that the above instrumentation has been calibrated and tested to **meet or exceed** the published specifications. This calibration and testing was performed using instrumentation and standards that are traceable to the **National Institute for Standards and Technology (NIST).**

Standard Uncertainty of Barometric Pressure Measurement = ±1.32mb

The output (in kPa) for this BP20 sensor is defined by: **P = (21.79 x Vout) + 10.34**

Criteria	Value	Units
BP20 Slope	21.79	kPa / Volt
BP20 Offset	10.34	kPa

Slope (Scale Factor) and Offset Conversion Chart for Renewable NRG Systems' Data Loggers.

To Scale to…	SymphoniePLUS3 and Older *[Symphonie Data Retriever (SDR) software]*		SymphoniePRO Data Logger *[SymphoniePRO Desktop Application]*	
	enter Scale Factor	and enter Offset	enter Scale Factor	and enter Offset
hPa (mb)	0.4255	648.126	217.9	103.4
kPa	0.04255	64.813	21.79	10.34
inches of mercury	0.01257	19.139	6.435	3.054

Procedure: WI-ELE-58

Calibration performed by: WJK **Date:** 3/8/2017

Renewable NRG Systems' management system has been certified to ISO 9001: 2008.

SEE THE POTENTIAL

110 Riggs Road - Hinesburg - VT 05461 USA · TEL (802) 482-2255 · FAX (802) 482-2272 · EMAIL sales@rnrgsystems.com