ANEXO I: FICHA TÉCNICA MÓDULOS FV

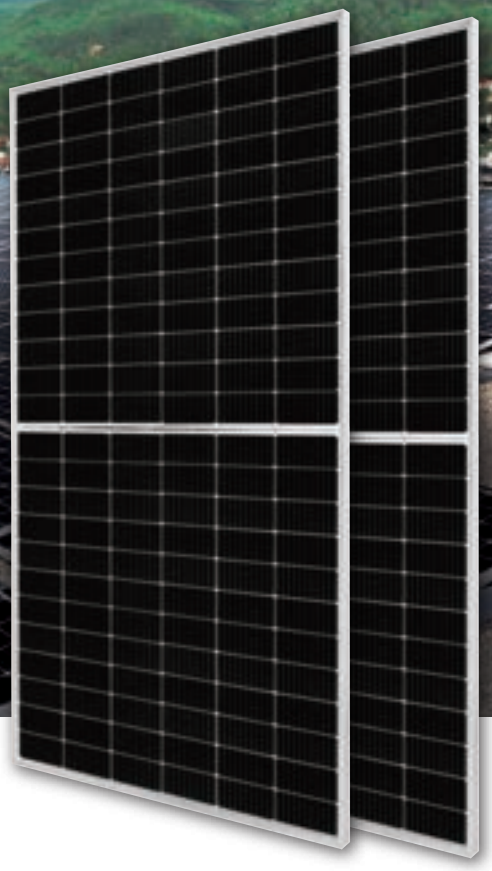
Harvest the Sunshine

DEEP BLUE 3.0

Mono

550W MBB Bifacial Mono PERC Half-cell Double Glass Module

JAM72D30 525-550/MB Series



Introduction

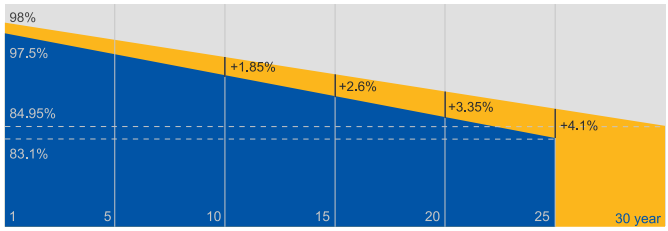
Assembled with 11BB bifacial PERCIUM cells and half-cell configuration, these double glass modules have the capability of converting the incident light from the rear side together with the front side into electricity, providing higher output power, lower temperature coefficient, less shading loss, as well as enhanced tolerance for mechanical loading.

- Higher output power
- More reliable, more stable power generation
- Less shading effect
- Lower temperature coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

0.45% Annual Degradation Over 30 years



- Bifacial double glass module linear power warranty
- Standard module linear power warranty

Comprehensive Certificates

- IEC 61215, IEC 61730,UL 61215, UL 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

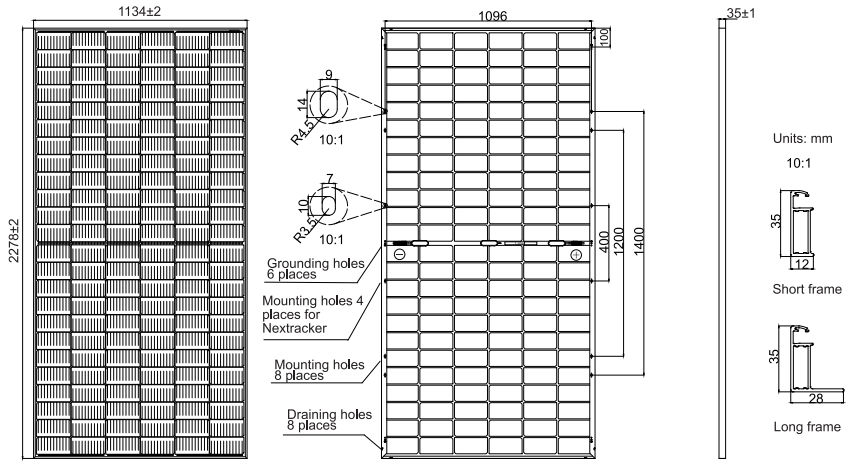
JA SOLAR

www.jasolar.com

Specifications subject to technical changes and tests.
JA Solar reserves the right of final interpretation.

JAM72D30 525-550/MB Series

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×35±1mm
Cable Cross Section Size	4mm²（IEC), 12 AWG(UL)
No. of cells	144(6×24）
Junction Box	IP68, 3 diodes
Connector	MC4-EVO2/ QC 4.10-35
Cable Length (Including Connector)	Portrait:300mm(+)/400mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	31pcs/Pallet 620pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Maximum Power(Pmax) [W]	525	530	535	540	545	550
Open Circuit Voltage(Voc) [V]	49.15	49.30	49.45	49.60	49.75	49.90
Maximum Power Voltage(Vmp) [V]	41.15	41.31	41.47	41.64	41.80	41.96
Short Circuit Current(Isc) [A]	13.65	13.72	13.79	13.86	13.93	14.00
Maximum Power Current(Imp) [A]	12.76	12.83	12.90	12.97	13.04	13.11
Module Efficiency [%]	20.3	20.5	20.7	20.9	21.1	21.3
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/°C					
Temperature Coefficient of Voc(β_Voc)	-0.275%/°C					
Temperature Coefficient of Pmax(γ_Pmp)	-0.350%/°C					
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer.They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Max Power(Pmax) [W]	562	567	572	578	583	589
Open Circuit Voltage(Voc) [V]	49.54	49.67	49.80	49.93	50.03	50.21
Max Power Voltage(Vmp) [V]	41.14	41.31	41.47	41.65	41.78	41.95
Short Circuit Current(Isc) [A]	14.61	14.68	14.76	14.83	14.91	14.98
Max Power Current(Imp) [A]	13.65	13.73	13.80	13.88	13.95	14.03
Irradiation Ratio(rear/front)	10%					

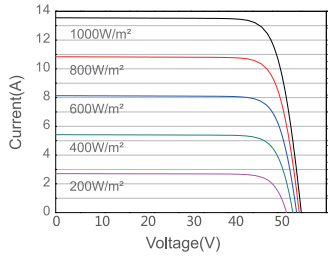
*For NexTracker installations, Maximum Static Load, Front is 2400Pa while Maximum Static Load, Back is 2400Pa.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

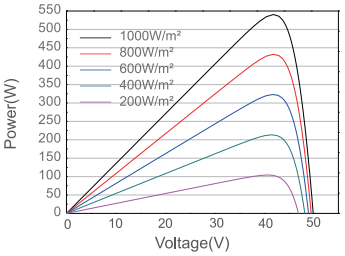
Maximum System Voltage	1500V DC
Operating Temperature	-40°C~+85°C
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2°C
Bifaciality**	70%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

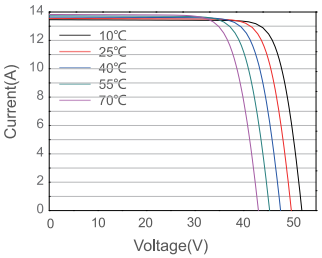
Current-Voltage Curve JAM72D30-540/MB



Power-Voltage Curve JAM72D30-540/MB



Current-Voltage Curve JAM72D30-540/MB



ANEXO II: FICHA TÉCNICA INVERSORES

SG350HX

Inversor String Multi MPPT para sistemas de 1500 Vdc

NEW

ALTO RENDIMIENTO

- Hasta 16 MPPTs con una eficiencia máxima del 99%
- 20 A por string, compatible con módulos +500Wp
- Intercambio de datos con el tracker para mejorar el rendimiento

BAJO COSTE

- Función Q a la noche, ahorra en inversión
- Comunicación PLC
- Escaneo y diagnostico de curva IV, O&M activo

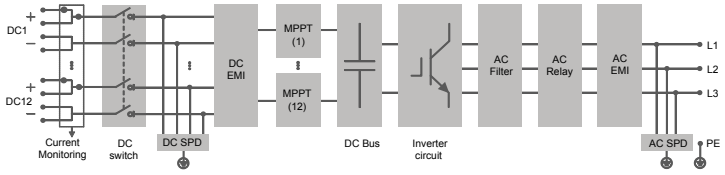
SEGURIDAD COMPROBADA

- 2 strings por MPPT, sin riesgo de conexión inversa
- Monitorización AC y DC en tiempo real
- Interruptor DC integrado, corta automaticamente el fallo

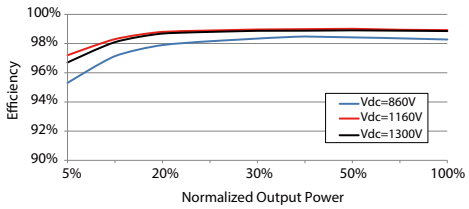
SOPORTE DE RED

- SCR≥1.16 funcionamiento estable en redes extremadamente débiles
- Tiempo de respuesta de la potencia reactiva <30ms
- Cumple con la seguridad global y el código de red

DIAGRAMA DEL CIRCUITO



CURVA DE EFICIENCIA



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Denominación	SG350HX
Entrada (DC)	
Tensión máxima de entrada FV	1500 V
Tensión mínima / Tensión de arranque	500 V / 550 V
Tensión de entrada nominal	1080 V
Rango de tensión MPP	500 V – 1500 V
No. de entradas MPP independientes	12 (opcional: 14/16)
No. máximo de conectores de entrada por MPPT	2
Corriente máxima de entrada FV	12 * 40 A (Opcional: 14 * 30 A / 16 * 30 A)
Corriente máxima de cortocircuito de DC por MPPT	60 A
Salida (AC)	
Potencia de salida de AC	352 kVA @ 30℃ / 320 kVA @40 ℃ / 295 kVA @50℃
Corriente máxima de salida de AC	254 A
Tensión nominal de AC	3 / PE, 800 V
Rango de tensión de AC	640 – 920V
Frecuencia nominal de red / Rango de frecuencia de red	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz
THD	< 3 % (potencia nominal)
Inyeccion de corriente DC	< 0.5 % In
FP a potencia nominal / FP ajustable	> 0.99 / 0.8 inductivo – 0.8 capacitativo
Fases de inyección / Fases de conexión	3 / 3
Eficiencia	
Eficiencia máx / Eficiencia Europea / Eficiencia CEC	99.02 % / 98.8 % / 98.5%
Protección	
Protección de conexión DC inversa	Sí
Protección de cortocircuito de AC	Sí
Protección contra corriente de fuga	Sí
Monitorización de red	Sí
Monitorización de fallo a tierra	Sí
Interruptor DC/AC	Sí / No
Monitorización de corrientes string FV	Sí
Función Q en noche	Sí
Anti-PID y Función de recuperación PID	Opcional
Protección contra sobretensión	DC Tipo II / AC Tipo II
Datos Generales	
Dimensiones (W*H*D)	1136 * 870 * 361 mm (44.7'' * 34.3'' * 14.2'')
Peso	≤116 kg(≤255.7 lbs)
Método de aislamiento	Sin transformador
Grado de protección de entrada	IP66 (NEMA 4X)
Consumo nocturno	< 6 W
Rango de temperatura ambiente de funcionamiento	-30 to 60℃(-22 to 140 ˚F)
Humedad relativa aceptable (sin condensación)	0 – 100 %
Método de refrigeración	Refrigeración forzada inteligente
Altitud máxima de funcionamiento	4000 m (> 3000 m derating) / 13123 ft (> 9843 ft derating)
Display	LED, Bluetooth+APP
Comunicación	RS485 / PLC
Tipo de conexión DC	MC4-Evo2 (Max. 6 mm², optional 10mm² / Max. 10AWG, optional 8AWG)
Tipo de conexión AC	Support OT/DT terminal (Max. 400 mm² / 789 Kcmil)
Certificación	IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683, VDE-AR-N 4110:2018, VDE-AR-N 4120:2018, EN 50549-1/2, UNE 206007-1:2013, P.O.12.3, UTE C15-712-1:2013, UL1741, UL1741SA, IEEE1547, IEEE1547.1, CSA C22.2 107.1-01-2001, California Rule 21, UL1699B
Soporte de red	Función Q en noche, LVRT, HVRT, control de potencia activa y reactiva, control de rampa de potencia, control Q-U y control, P-f

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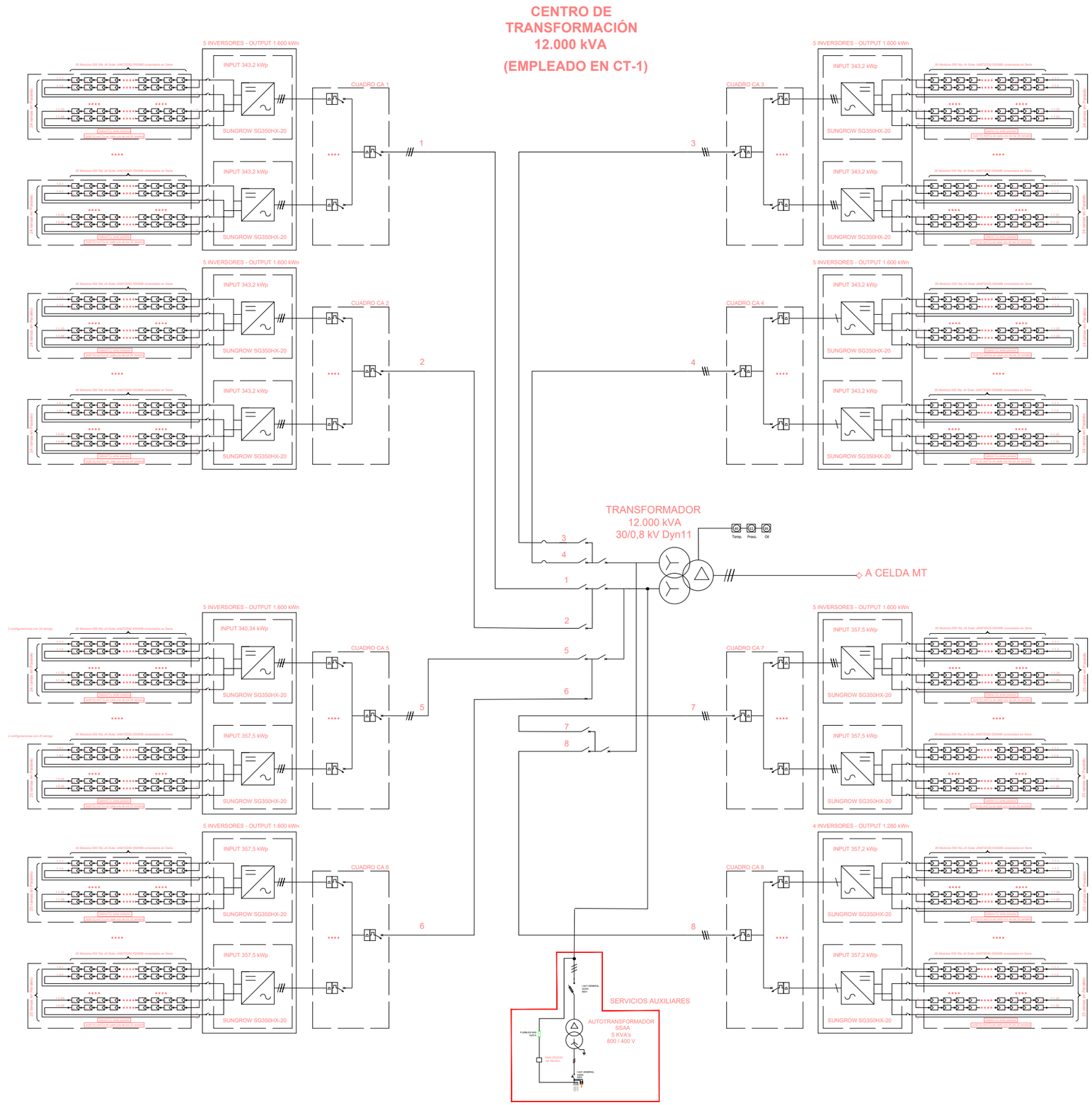
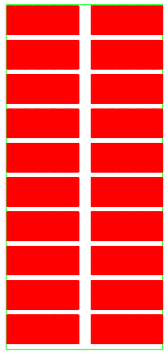
ANEXO III: ESQUEMA UNIFILAR BT-MT PFV: CT TIPO





LOCALIZACIÓN

SIN ESCALA

PROYECTO:

PARQUE FOTOVOLTAICO ARGELIA

CONTENIDO:

ESQUEMA UNIFILAR BT/MT CT TIPO

UBICACIÓN:

IN-SALAH (ARGELIA)

PROPIETARIO:

UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:

JUAN LÁZARO MARÍN

FIRMAS:

Sistema de Gestión
ISO 9001:2008
ISO 14001:2004
OHSAS 18001:2007

TÜVRheinland CERTIFICADO

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ID 9108633571

REV	FECHA	DISEÑO	APROB.	MODIFICACIÓN

EMPRESA:

Escuela de Ingeniería y Arquitectura Universidad Zaragoza

REF: 1

DIBUJADO: J.L.M.

REVISADO: J.L.M

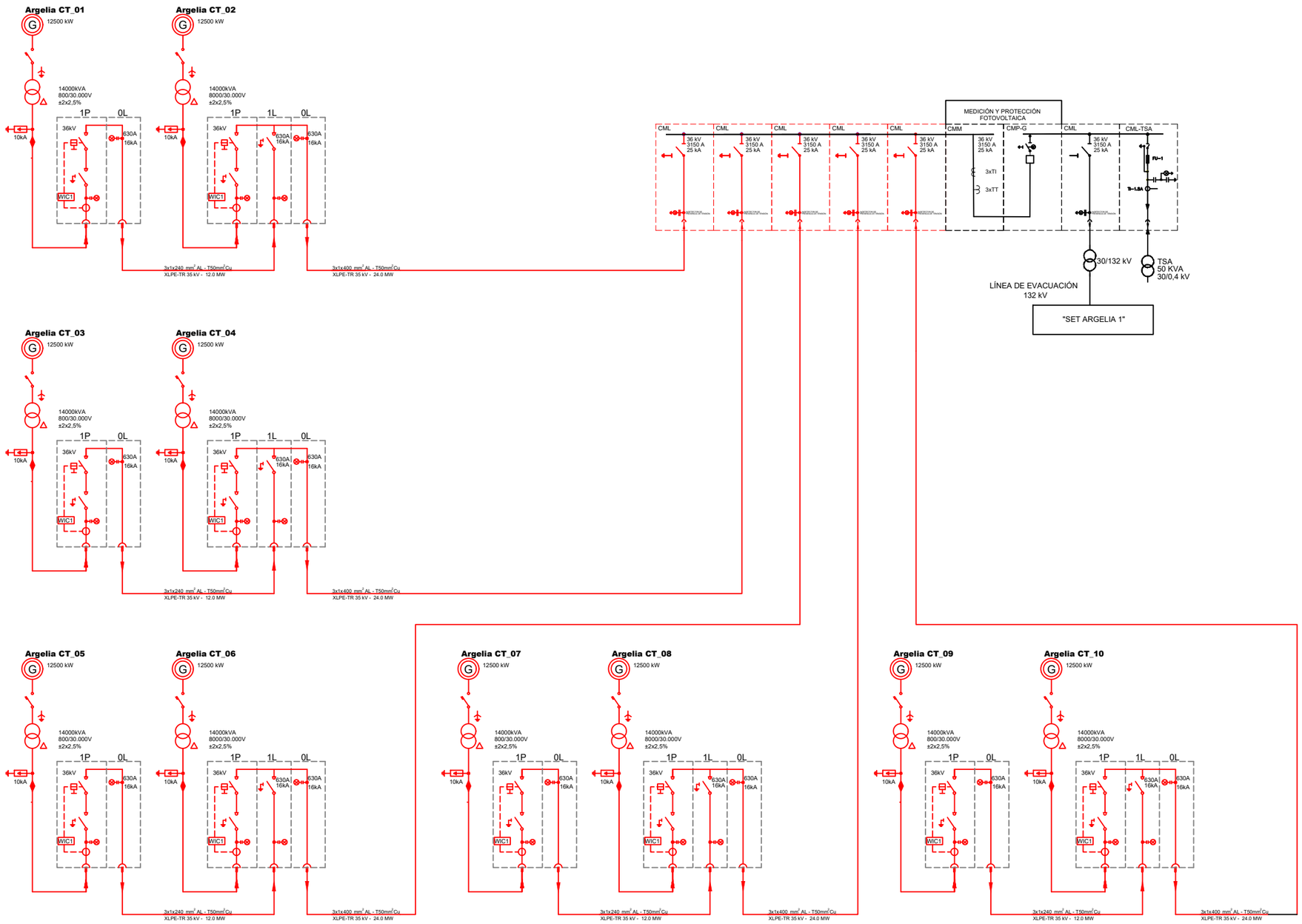
FECHA: MAYO/2023

ESCALA: S/E

VERSIÓN: 1

A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768

ANEXO IV: ESQUEMA UNIFILAR GENERAL DE EVACUACÓN PFV



LOCALIZACIÓN

SIN ESCALA

PROYECTO:

PARQUE FOTOVOLTAICO ARGELIA

CONTENIDO:

ESQUEMA UNIFILAR DE EVACUACIÓN

UBICACIÓN:

IN-SALAH (ARGELIA)

PROPIETARIO:

UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:

JUAN LÁZARO MARÍN

FIRMAS:

TÜVRheinland CERTIFICADO

Sistema de Gestión
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Escuela de Ingeniería y Arquitectura Universidad Zaragoza

REF: 2

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REVISADO: J.L.M

FECHA: MAYO/2023

ESCALA: SE

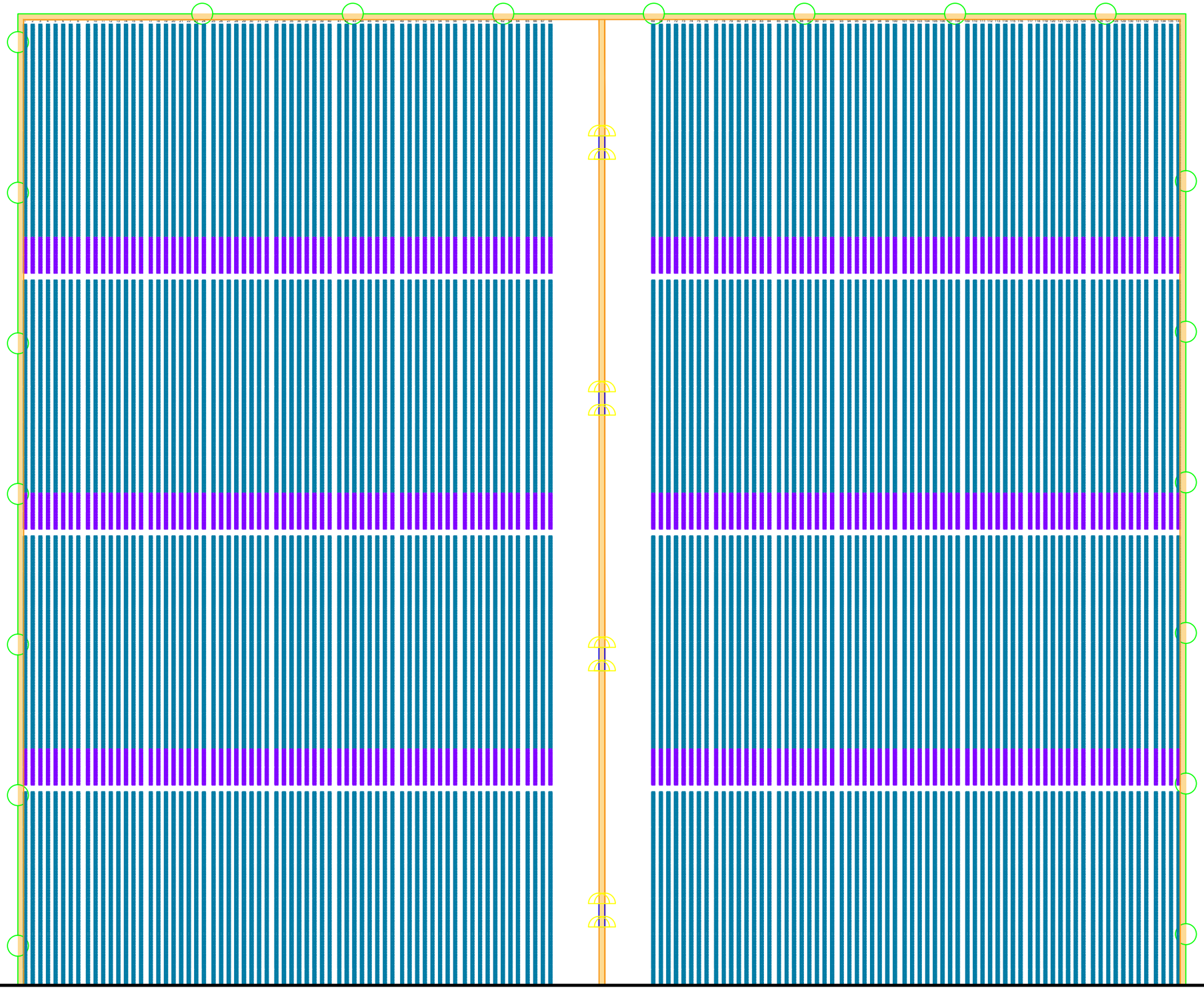
VERSIÓN: 1

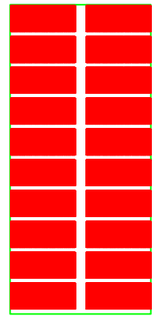
A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768

ANEXO V: LAYOUT PARQUE FOTOVOLTAICO

PFV HYBRID ARGELIA
247.520 módulos (550 Wp)
Potencia pico = 136,136 MWp
Potencia nominal = 124,8 MWn

LEYENDA	
SÍMBOLO	DESCRIPCIÓN
	VALLADO FV
	CAMINO PERIMETRAL
	CENTRO TRANSFORMACIÓN





LOCALIZACIÓN
SIN ESCALA

PROYECTO:
PARQUE FOTOVOLTAICO ARGELIA

CONTENIDO:
LAYOUT GENERAL

UBICACIÓN:
IN-SALAH (ARGELIA)

PROPIETARIO:
UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:
JUAN LÁZARO MARÍN

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Escuela de Ingeniería y Arquitectura Universidad Zaragoza

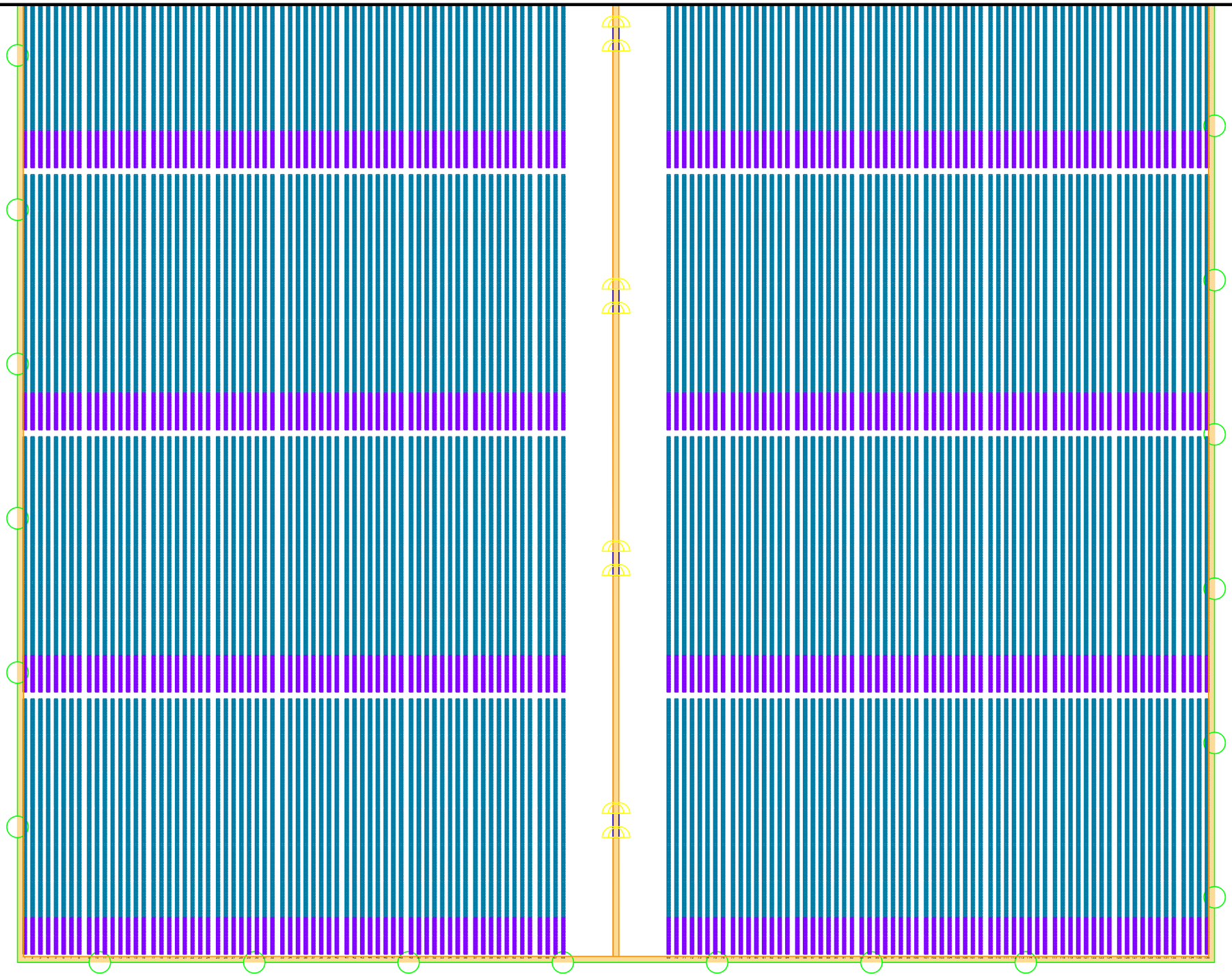
REF: 3.1

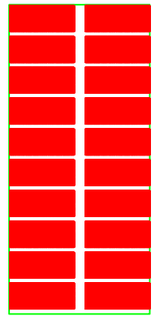
DIBUJADO: J.L.M.
REVISADO: J.L.M

FECHA: MAYO/2023

ESCALA: 1/3.500
VERSIÓN: 0

A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768





LOCALIZACIÓN

SIN ESCALA

PROYECTO:
PARQUE FOTOVOLTAICO ARGELIA

CONTENIDO:
LAYOUT GENERAL

UBICACIÓN:
IN-SALAH (ARGELIA)

PROPIETARIO:
UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:
JUAN LÁZARO MARÍN

FIRMAS:

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REV	FECHA	DISEÑO	APROB.	MODIFICACIÓN

PFV HYBRID ARGELIA
247.520 módulos (550 Wp)
Potencia pico = 136,136 MWp
Potencia nominal = 124,8 MWn

LEYENDA

SÍMBOLO	DESCRIPCIÓN
	VALLADO FV
	CAMINO PERIMETRAL
	CENTRO TRANSFORMACIÓN

EMPRESA:
Escuela de Ingeniería y Arquitectura Universidad Zaragoza

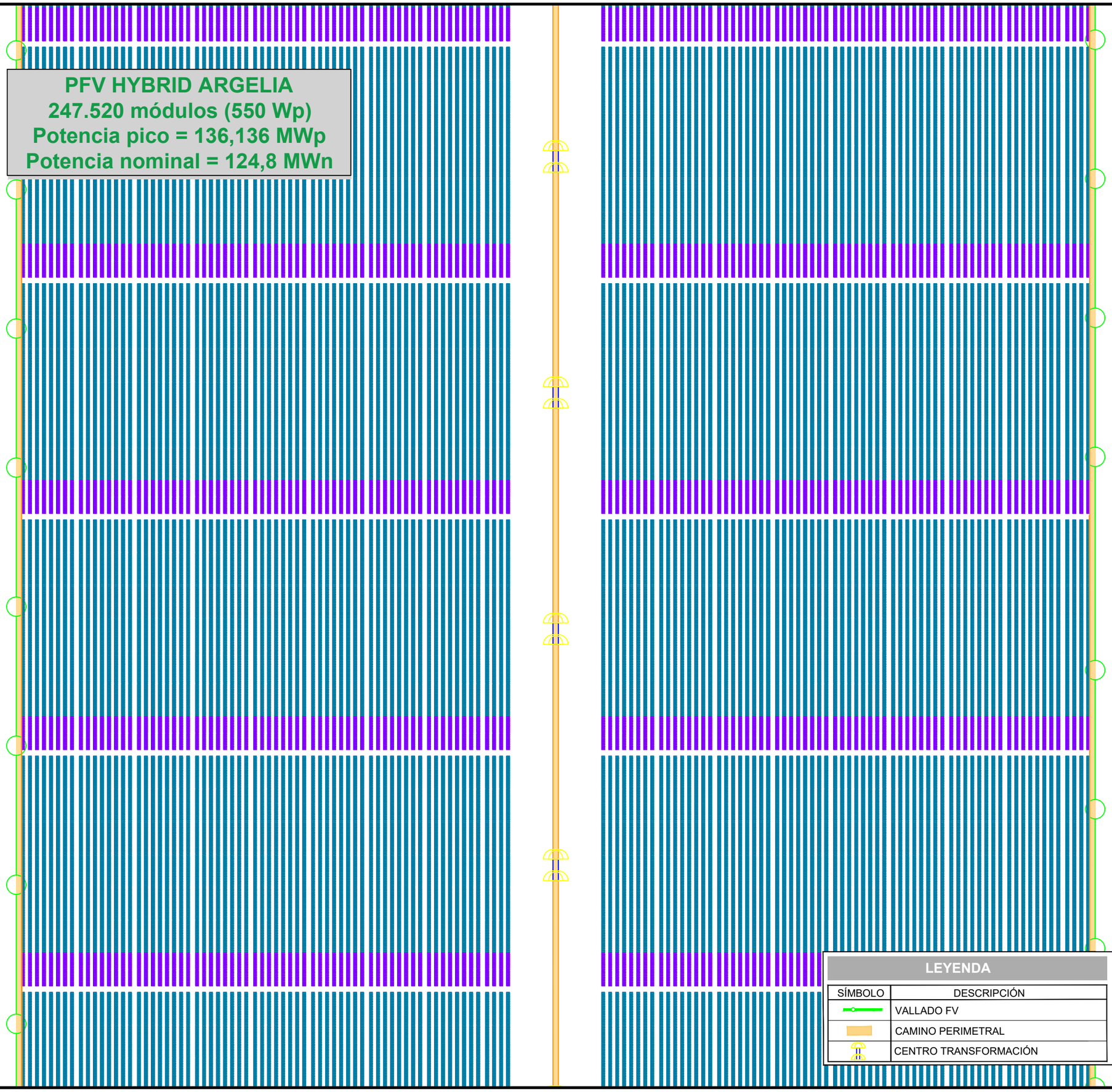
REF: 3.3

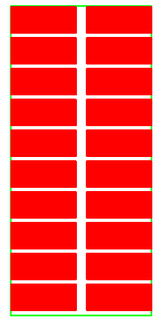
DIBUJADO: J.L.M.
REVISADO: J.L.M

FECHA: MAYO/2023

ESCALA: 1/3.500
VERSIÓN: 0

A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768





LOCALIZACIÓN

SIN ESCALA

PROYECTO:
PARQUE FOTOVOLTAICO ARGELIA

CONTENIDO:
LAYOUT GENERAL

UBICACIÓN:
IN-SALAH (ARGELIA)

PROPIETARIO:
UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:
JUAN LÁZARO MARÍN

FIRMAS:

Sistema de Gestión
ISO 9001:2008
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EMPRESA:
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REF: 3.2

DIBUJADO: J.L.M.
REVISADO: J.L.M

FECHA: MAYO/2023

ESCALA: 1/3.500
VERSIÓN: 0

A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768

LEYENDA

SÍMBOLO	DESCRIPCIÓN
	VALLADO FV
	CAMINO PERIMETRAL
	CENTRO TRANSFORMACIÓN

ANEXO VI: FICHA TÉCNICA TURBINA EÓLCIA

Siemens Gamesa 4.X
Hacia la siguiente generación

SIEMENS Gamesa
RENEWABLE ENERGY

Solución de referencia en su segmento para una mayor eficiencia y LCoE reducido

Mejora continua con un nuevo sistema de control avanzado y una aerodinámica mejorada

Siemens Gamesa, su aliado tecnológico de confianza

Una de las claves del éxito de Siemens Gamesa es el desarrollo constante de nuevos y avanzados productos adaptados al caso de negocio de cada cliente. Nos esforzamos por ofrecer las mejores soluciones tecnológicas para cada proyecto, al tiempo que reducimos el Coste de Energía para garantizar retornos a largo plazo.

Por esta razón, ponemos a disposición de nuestros clientes un catálogo de producto optimizado y eficiente, avalado por tecnologías ampliamente validadas, y por nuestras mejores credenciales:

- La confianza de nuestros clientes: casi 132 GW instalados en todo el mundo.
- Una experiencia acreditada a lo largo de más de 40 años de actividad que convierte a Siemens Gamesa en un referente para sus proyectos eólicos.
- Y el reconocimiento del sector.

Siemens Gamesa 4.X

La plataforma Siemens Gamesa 4.X es una de las últimas incorporaciones al catálogo de producto onshore. Con sus aerogeneradores SG 5.0-132 y SG 5.0-145, dos modelos de referencia para emplazamientos de vientos medios y altos, Siemens Gamesa 4.X se asienta en la experiencia operativa acumulada por la compañía en el mercado eólico.

Siemens Gamesa 4.X representa el compromiso de Siemens Gamesa con la creación de valor para nuestros clientes mediante el desarrollo continuo de nuevas tecnologías que mejoren el rendimiento, la competitividad y la calidad de nuestros productos. Con un nuevo sistema de control vanguardista, una aerodinámica de palas mejorada y la modularidad estructural, los dos modelos ofrecen a nuestros clientes una mayor capacidad de adaptación a emplazamientos con muy diversas condiciones de viento y diferentes restricciones logísticas.

Tecnología demostrada Siemens Gamesa

Siemens Gamesa 4.X aprovecha el conocimiento adquirido en nuestros últimos productos e incorpora tecnologías innovadoras con el fin de conseguir una eficacia y una rentabilidad superior. Está basado en conceptos ya probados con una amplia presencia en el mercado como la combinación de una multiplicadora de tres etapas (dos etapas planetarias y una paralela) y un generador doblemente alimentado, que ofrecen el máximo nivel de fiabilidad. Además, la inclusión de un convertidor premium como opcional permite el cumplimiento de los requisitos de conexión a red más exigentes.

Las nuevas palas de 64,5 y 71 metros, realizadas en fibra de vidrio reforzada con resina de epoxi y tecnología de carbono pultruido, integran el know-how en aerodinámica y la tecnología DinoTails® Next Generation, que garantizan una máxima producción de energía y unos niveles de emisión de ruido reducidos.

Niveles superiores en eficiencia y rentabilidad

Con respecto a la generación anterior, Siemens Gamesa 4.X integra nuevas tecnologías y estrategias de control que optimizan la eficiencia de la turbina en función de las condiciones del emplazamiento, ofreciendo una potencia flexible dependiendo de los requerimientos de ruido, temperatura y prestaciones eléctricas del proyecto.

Con un incremento de más del 24% en AEP con respecto a la plataforma Siemens Gamesa 3.X, los aerogeneradores SG 5.0-132 y SG 5.0-145 son un referente en términos de LCoE y rentabilidad.

Dos aerogeneradores con potencia flexible, para configurar soluciones personalizadas y adaptadas a todo tipo de emplazamiento

Especificaciones técnicas

	SG 5.0-132	SG 5.0-145
Datos generales		
Potencia nominal	5.0 MW	
Clase IEC	IA	IIB
Potencia flexible	4.0-5.0 MW	4.0-5.2 MW
Control	Pitch y velocidad variable	
Temperatura operativa estándar	Rango desde -20ºC hasta 45ºC (con de-rating) [1]	
Rotor		
Diámetro	132 m	145 m
Área de barrido	13.685 m^2	16.513 m^2
Palas		
Longitud	64,5 m	71 m
Perfil	Siemens Gamesa	
Material	Fibra de vidrio reforzada con resina de epoxi	
Torre		
Tipo	Diferentes tecnologías disponibles	
Altura	84 m y según emplazamiento	91, 102,5, 127,5 m y según emplazamiento
Multiplicadora		
Tipo	3 etapas	
Generador		
Tipo	Doblemente alimentado	
Tensión	690 V AC	
Frecuencia	50 Hz/60 Hz	
Clase de protección	IP 54	
Factor de potencia	0,9 CAP-0,9 IND en todo el rango de potencias [2]	

[1] Diferentes versiones y kits opcionales disponibles para adaptar la máquina a bajas temperaturas y ambientes salino y polvoriento.

[2] Factor de potencia en bornas de salida del generador en el lado de baja tensión antes de la entrada del transformador.

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Halfway House
Midrand 1685

Suecia
Evenemangsgatan 21
169 79 Solna

Turquía
Esentepe mahallesi Kartal
Yakacik Yolu No 111
34870 Kartal
Estambul

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Ben Nghe ward District 1
Ciudad Ho Chi Minh

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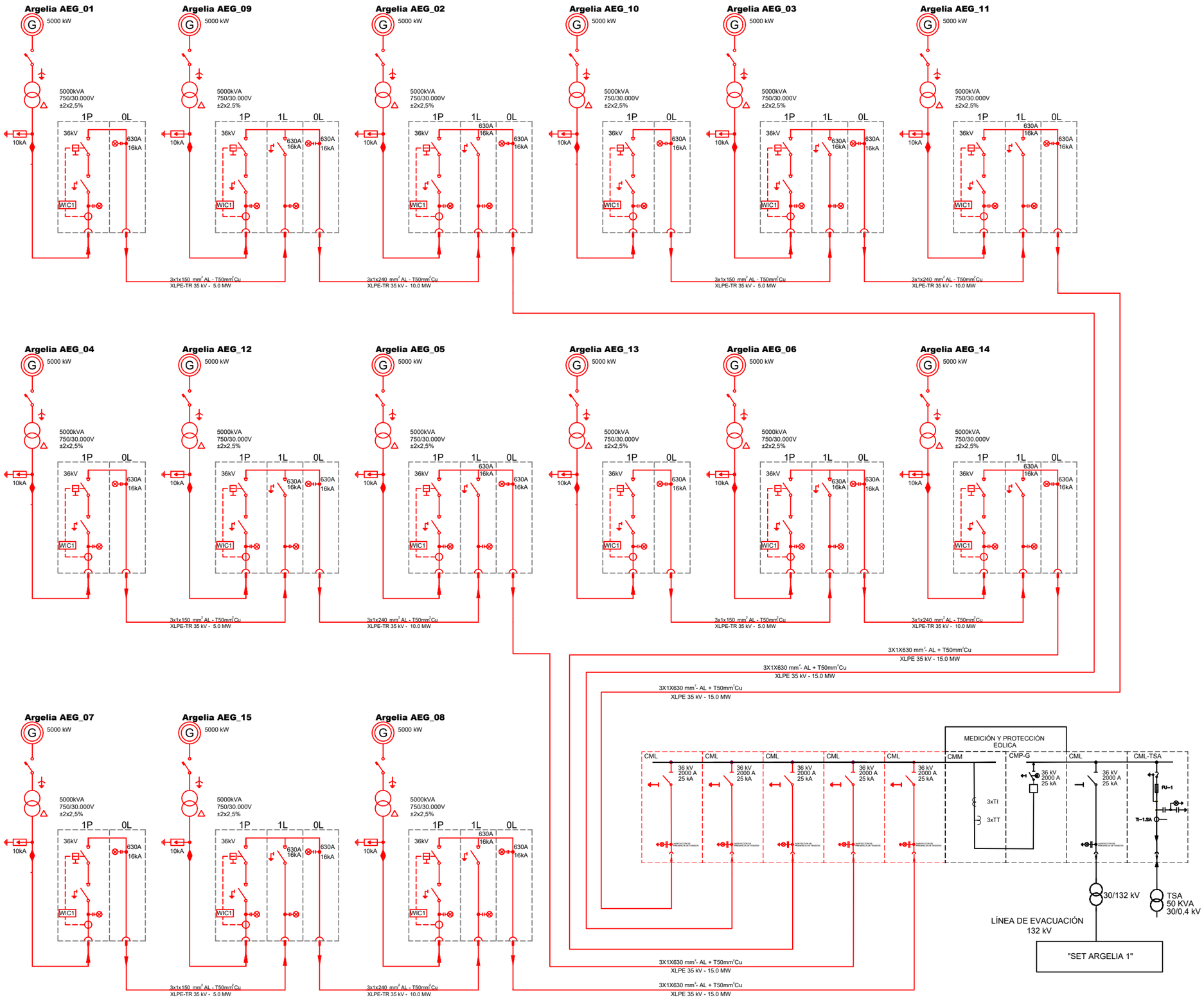
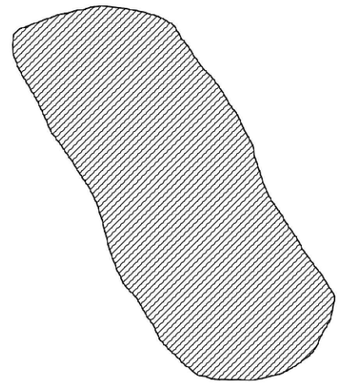
05/2023

ANEXO VII: ESQUEMA UNIFILAR PE





LOCALIZACIÓN

SIN ESCALA

PROYECTO:

PARQUE EÓLICO ARGELIA

CONTENIDO:

ESQUEMA UNIFILAR
DE EVACUACIÓN

UBICACIÓN:

IN-SALAH (ARGELIA)

PROPIETARIO:

UNIVERSIDAD DE ZARAGOZA

PROFESIONAL RESPONSABLE:

JUAN LÁZARO MARÍN

FIRMAS:

Sistema de Gestión
ISO 9001:2008
ISO 14001:2004
OHSAS 18001:2007

TÜVRheinland CERTIFICADO

www.tuv.com
ID 9108633571

REV	FECHA	DISEÑO	APROB.	MODIFICACIÓN

EMPRESA:

Escuela de Ingeniería y Arquitectura Universidad Zaragoza

REF: 4

DIBUJADO: J.L.M

REVISADO: J.L.M

FECHA: MAYO/2023

ESCALA: SE

VERSIÓN: 1

A) ISO 2768
B) Clase de tolerancia, conforme a esta parte de la Norma ISO 2768

ANEXO VIII: INFORME DE PRODUCCIÓN FOTOVOLTAICA

Version 7.3.4

PVsyst - Simulation report

Grid-Connected System

Proyecto: PFV HYBRID ARGELIA

Variant: 247.520 x JA SOLAR 550 Wp + 390 INV HUAWEI 300 kW + 6,5 m + SEGUIDOR N-S + 136,136 MWp

Tracking system with backtracking

System power: 136.1 MWp

Argelia - Algeria

Juan Lázaro Marín

Project: PFV_HYBRID_ARGELIA

Variant: 247.520 x JA SOLAR 550 Wp + 390 INV HUAWEI 300 kW + 6,5 m + SEGUIDOR N-S + 136,136 MWp

Enerland (Spain)

Project summary

Geographical Site
Argelia
Algeria

Situation

Latitude	28.26 °N
Longitude	2.09 °E
Altitude	618 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Argelia
Meteonorm 8.1 (1998-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

Orientation	
Tracking plane, horizontal N-S axis	
Axis azimuth	0 °

Tracking algorithm
Irradiance optimization
Backtracking activated

Near Shadings

According to strings	
Electrical effect	80 %
Diffuse shading	Automatic

System information

PV Array	
Nb. of modules	247520 units
Pnom total	136.1 MWp

Inverters	
Nb. of units	390 units
Pnom total	124.8 MWac
Pnom ratio	1.091

User's needs
Unlimited load (grid)

Results summary

Produced Energy	309518 MWh/year	Specific production	2274 kWh/kWp/year	Perf. Ratio PR	85.01 %
Apparent energy	316321 MVAh/year				

Table of contents

Project and results summary 2
General parameters, PV Array Characteristics, System losses 3
Near shading definition - Iso-shadings diagram 6
Main results 7
Loss diagram 8
Predef. graphs 9
P50 - P90 evaluation 10
Single-line diagram 11

General parameters

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

Orientation

Tracking plane, horizontal N-S axis	
Axis azimuth	0 °

Tracking algorithm

Irradiance optimization
Backtracking activated

Backtracking array

Nb. of trackers	5440 units

Sizes

Tracker Spacing	6.50 m
Collector width	2.28 m
Ground Cov. Ratio (GCR)	35.0 %
Phi min / max.	-/+ 55.0 °

Backtracking strategy

Phi limits for BT	-/+ 69.4 °
Backtracking pitch	6.50 m
Backtracking width	2.28 m

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon

Free Horizon

Near Shadings

According to strings

Electrical effect	80 %
Diffuse shading	Automatic

User's needs

Unlimited load (grid)

Bifacial system

Model	2D Calculation unlimited trackers

Bifacial model geometry

Tracker Spacing	6.50 m
Tracker width	2.28 m
GCR	35.0 %
Axis height above ground	1.80 m

Bifacial model definitions

Ground albedo	0.30
Bifaciality factor	66 %
Rear shading factor	9.9 %
Rear mismatch loss	5.4 %
Shed transparent fraction	0.0 %

Grid injection point

Power factor

Cos(phi) (leading)	0.980

PV Array Characteristics

PV module

Manufacturer	JA Solar
Model	JAM72-D30-550-MB
(Original PVsyst database)	
Unit Nom. Power	550 Wp
Number of PV modules	247520 units
Nominal (STC)	136.1 MWp
Modules	9520 Strings x 26 In series
At operating cond. (50°C)	
Pmpp	125.0 MWp
U mpp	989 V
I mpp	126408 A

Inverter

Manufacturer	Sungrow
Model	SG350HX-20A
(Custom parameters definition)	
Unit Nom. Power	320 kWac
Number of inverters	390 units
Total power	124800 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	352 kWac
Pnom ratio (DC:AC)	1.09
Power sharing within this inverter	

PV Array Characteristics

Total PV power

Nominal (STC)	136136 kWp
Total	247520 modules
Module area	639407 m²

Total inverter power

Total power	124800 kWac
Max. power	137280 kWac
Number of inverters	390 units
Pnom ratio	1.09
PNom limit forced to active power	

Array losses

Array Soiling Losses
Loss Fraction 5.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.043 mΩ
Loss Fraction 0.5 % at STC

LID - Light Induced Degradation
Loss Fraction 0.6 %

Module Quality Loss
Loss Fraction 0.5 %

Module mismatch losses
Loss Fraction 0.5 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): User defined profile

0°	30°	50°	65°	70°	75°	80°	85°	90°
1.000	1.000	0.989	0.945	0.890	0.821	0.681	0.439	0.000

System losses

Unavailability of the system
Time fraction 1.0 %
3.7 days,
3 periods

Auxiliaries loss
Proportionnal to Power 2.0 W/kW
0.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 800 Vac tri
Loss Fraction 1.41 % at STC
Inverter: SG350HX-20A
Wire section (390 Inv.) Alu 390 x 3 x 400 mm²
Average wires length 320 m

MV line up to Injection
MV Voltage 30 kV
Average each inverter
Wires Alu 3 x 400 mm²
Length 5000 m
Loss Fraction 0.61 % at STC

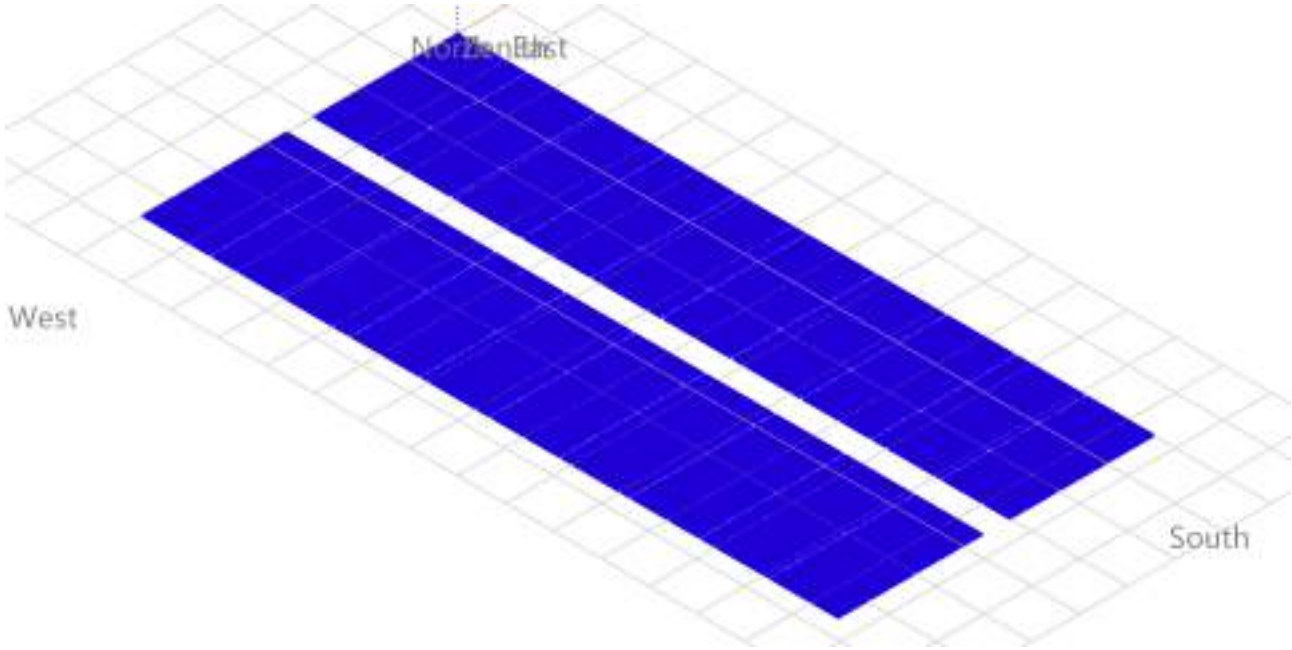
AC losses in transformers

MV transfo

Medium voltage	30 kV		
One transfo parameters		**Operating losses at STC (full system)**	
Nominal power at STC	13.40 MVA	Nb. identical MV transfos	10
Iron Loss (night disconnect)	14.20 kVA	Nominal power at STC	134.0 MVA
Iron loss fraction	0.11 % at STC	Iron loss (night disconnect)	142.04 kVA
Copper loss	121.67 kVA	Copper loss	1216.70 kVA
Copper loss fraction	0.91 % at STC		
Coils equivalent resistance	3 x 0.43 mΩ		

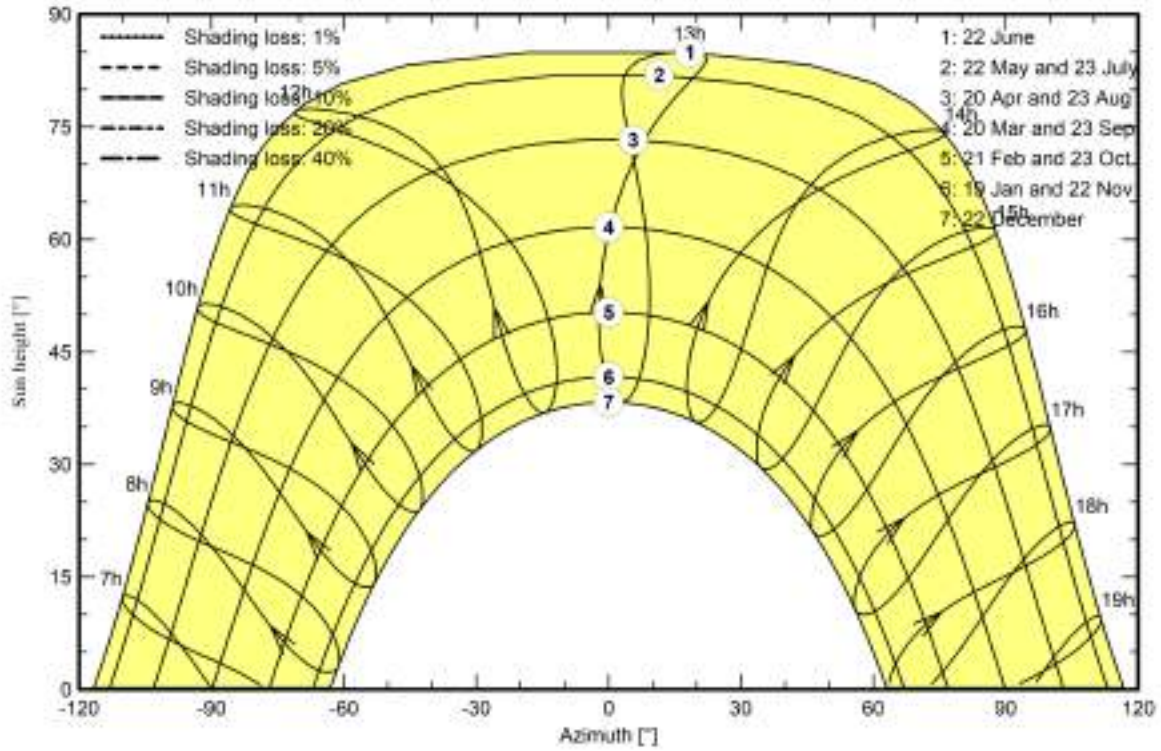
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



Project: PFV_HYBRID_ARGELIA

Variant: 247.520 x JA SOLAR 550 Wp + 390 INV HUAWEI 300 kW + 6,5 m + SEGUIDOR N-S + 136,136 MWp

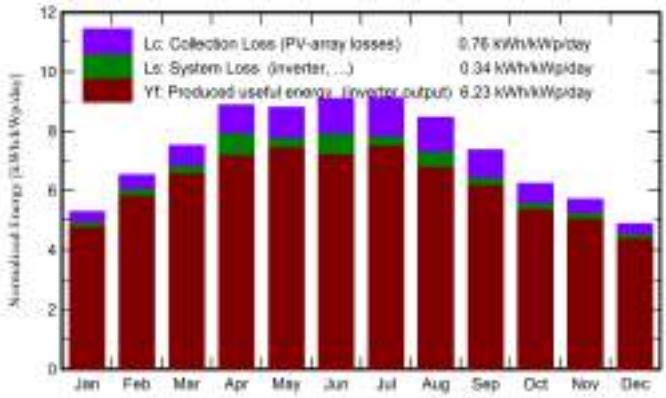
Enerland (Spain)

Main results

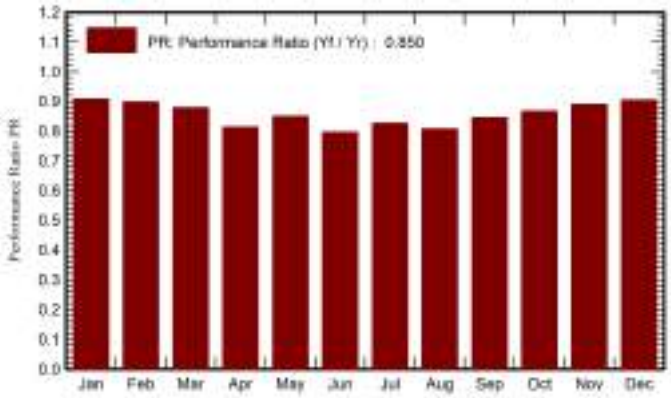
System Production

Produced Energy (P50)	309518 MWh/year	Specific production (P50)	2274 kWh/kWp/year	Perf. Ratio PR	85.01 %
Produced Energy (P90)	297285 MWh/year	Specific production (P90)	2184 kWh/kWp/year		
Produced Energy (P75)	303086 MWh/year	Specific production (P75)	2226 kWh/kWp/year		
Apparent energy	316321 MVAh/year				

Normalized productions (per installed kWp)



Performance Ratio PR



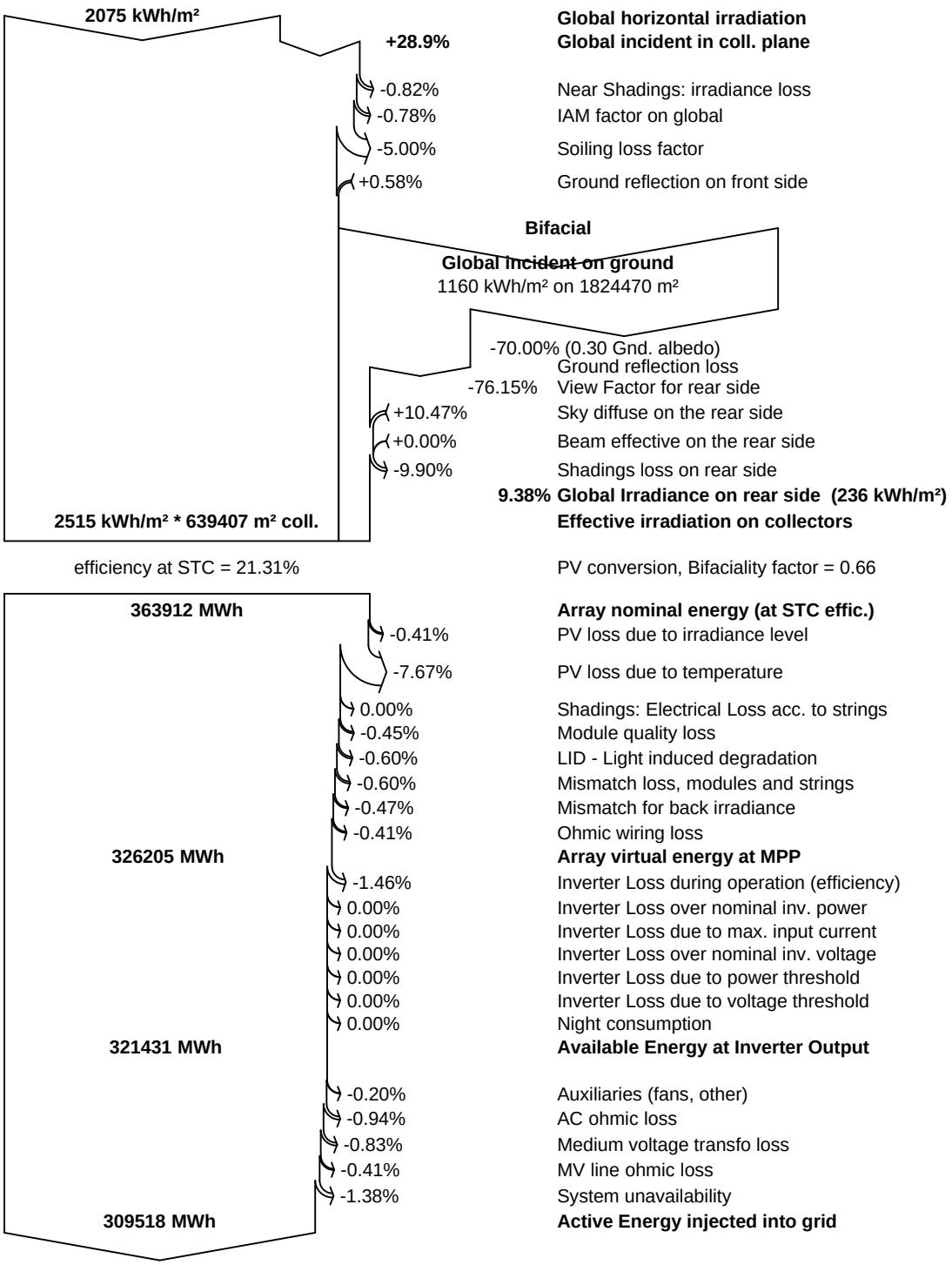
Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	MWh	MWh	ratio
January	119.0	35.27	11.42	164.1	153.1	20988	20272	0.908
February	135.0	38.32	14.43	182.7	171.7	23202	22349	0.899
March	177.0	61.71	20.14	233.1	219.5	29021	27889	0.879
April	204.5	67.29	24.39	266.3	251.0	32533	29498	0.814
May	219.5	88.94	29.88	272.9	257.1	32903	31592	0.850
June	222.5	92.61	33.90	273.2	257.3	32487	29606	0.796
July	226.9	86.94	37.09	282.9	266.8	33148	31806	0.826
August	212.2	87.15	36.14	262.5	247.2	30963	28836	0.807
September	172.8	70.65	32.01	221.0	207.8	26457	25451	0.846
October	149.4	59.15	26.47	193.3	181.3	23674	22824	0.867
November	126.0	35.19	17.64	171.2	160.5	21522	20749	0.890
December	110.7	31.47	12.88	151.5	141.4	19308	18647	0.904
Year	2075.4	754.67	24.76	2674.7	2514.7	326205	309518	0.850

Legends

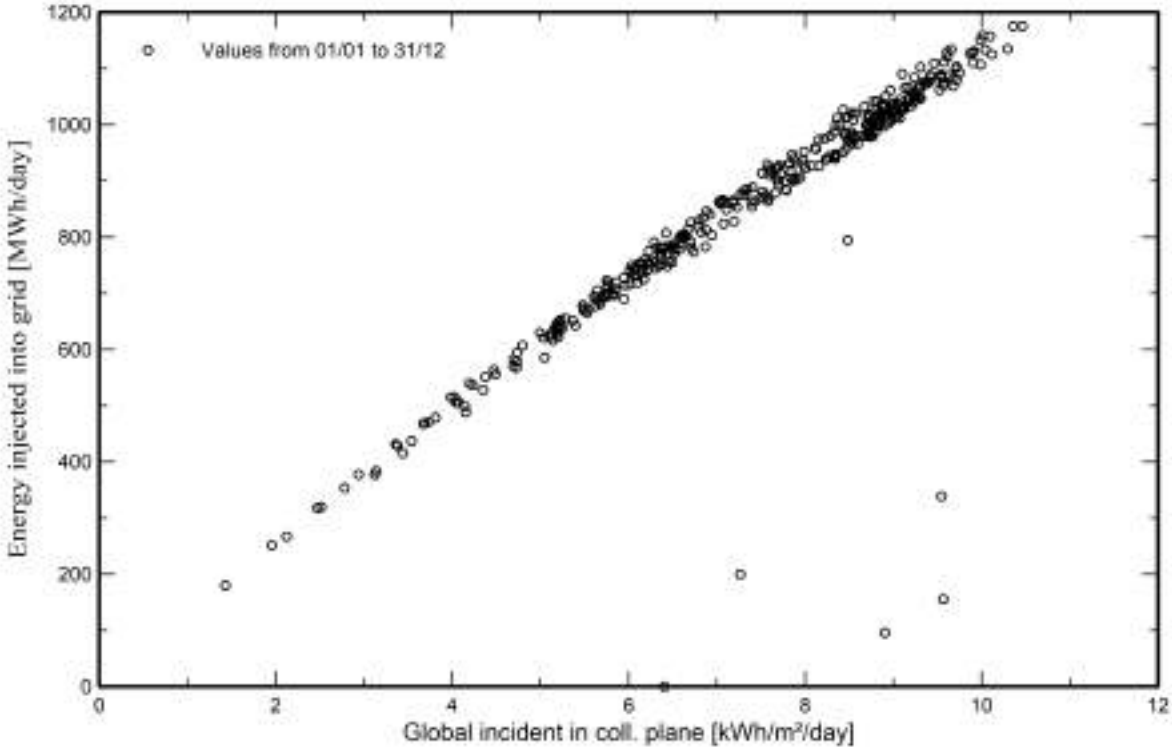
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

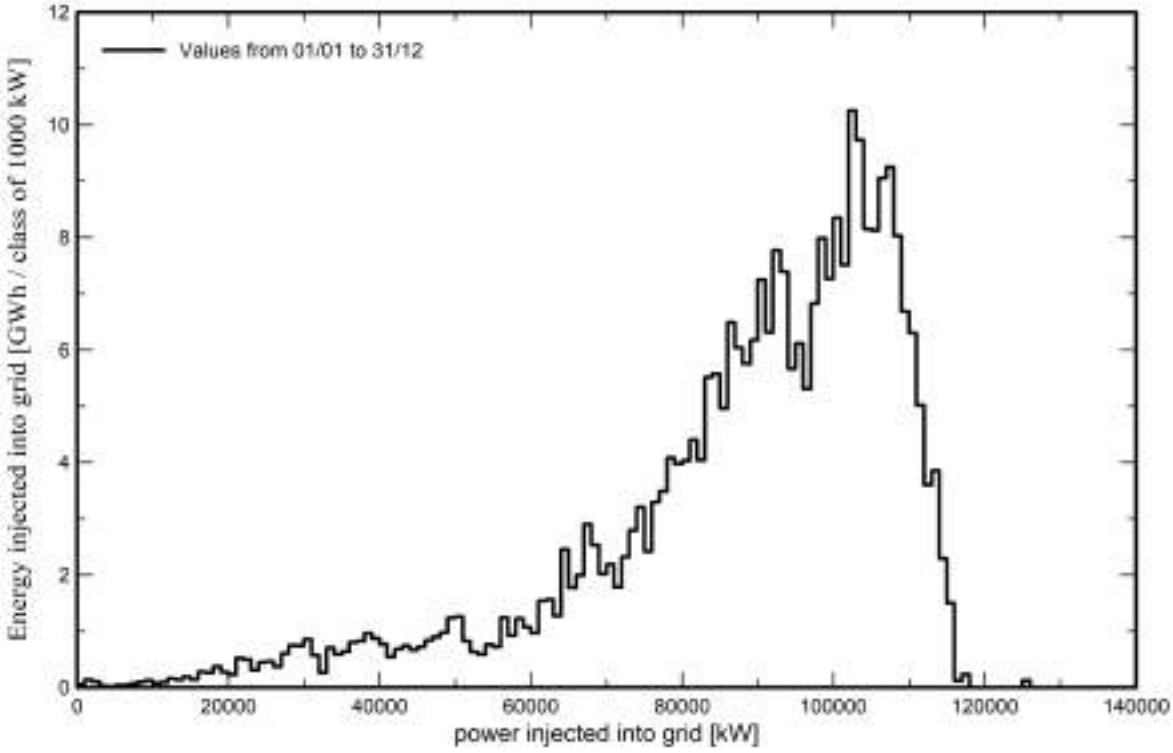


Predef. graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1998-2010), Sat=100%
Kind	TMY, multi-year
Year-to-year variability(Variance)	2.5 %
Specified Deviation	
Climate change	0.0 %

Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

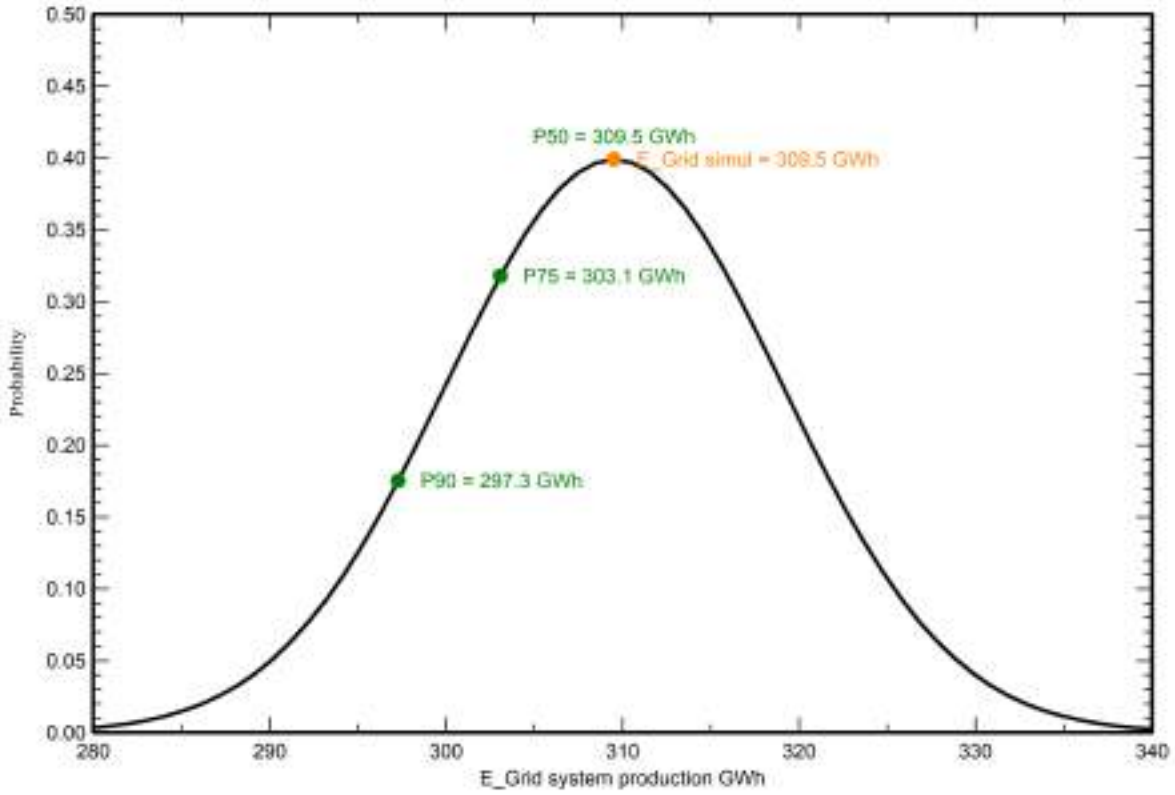
Global variability (meteo + system)

Variability (Quadratic sum)	3.1 %

Annual production probability

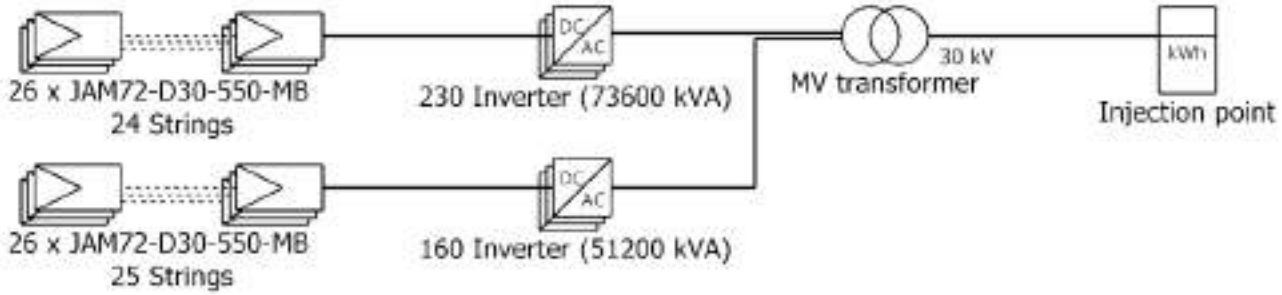
Variability	9.5 GWh
P50	309.5 GWh
P90	297.3 GWh
P75	303.1 GWh

Probability distribution



Single-line diagram

PVsyst V7.3.4
VC9, Simulation date:
03/06/23 19:12
with v7.3.4



PV module	JAM72-D30-550-MB
Inverter	SG350HX-20A
String	26 x JAM72-D30-550-MB

PFV_HYBRID_ARGELIA	Enerland (Spain)
VC9 : 247.520 x JA SOLAR 550 Wp + 3 90 INV HUAWEI 300 kW + 6,5 m + SE	03/06/23

ANEXO IX: INFORME PRODUCCIÓN EÓLICA

Project:
ARGEL-TFMJUAN

Licensed user:
Enerland Project Development, s.l.
Calle Bílbilis, número 18, nave A-4, Plataforma Logística de Zaragora
ES-50197 Zaragoza
+34 976 068 387

Calculated:
5/5/2023 10:58 AM/3.6.361

PARK - Main Result

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01

Wake Model N.O. Jensen (RISØ/EMD) Park 2 2018

Calculation performed in UTM (north)-WGS84 Zone: 31
At the site centre the difference between grid north and true north is: -0.5°

Power curve correction method
New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>
Air density calculation method
Height dependent, temperature from climate station
Station: IN SALAH V3 2014
Base temperature: 26.3 °C at 293.0 m
Base pressure: 1013.3 hPa at 0.0 m
Air density for Site center in key hub height: 610.0 m + 102.0 m = 1.097 kg/m³ -> 89.5 % of Std
Relative humidity: 0.0 %

Wake Model Parameters
Wake decay constant 0.090 DTU default onshore
Hub height independent

Blockage
Blockage Model: Self similar model (Forsting: 2017)

Gamma (?)	Alpha (a)	Beta (ß)	Lambda (?)	Eta (?)
1.100	0.889	1.414	0.587	1.320

Note: When wake reductions are mentioned in this report, it also includes reduction from blockage.

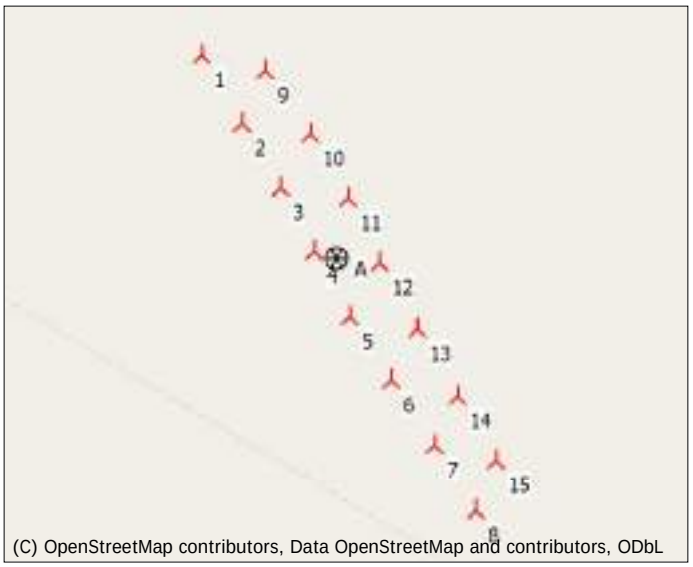
Omnidirectional displacement height from objects

Wake calculation settings

Angle [°]			Wind speed [m/s]		
start	end	step	start	end	step
0.5	360.0	1.0	0.5	30.5	1.0

Wind statistics DZ CERRA_N28.161557_E002.004104 (2) - 150.00 m.wws

WAsP version WAsP 12 Version 12.07.0056



Scale 1:125,000
New WTG Site Data

Key results for height 102.0 m above ground level

Terrain UTM (north)-WGS84 Zone: 31

	Easting	Northing	Name of wind distribution	Type	Wind energy [kWh/m²]	Mean wind speed [m/s]	Equivalent roughness
A	402,297.28	3,115,622.92	Site data: WAsP (5)	WAsP (WAsP 12 Version 12.07.0056)	2,343	7.0	0.8

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Wake loss [%]	Specific results¤) Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Mean wind speed @hub height [m/s]
Wind farm	236,623.1	244,616.4	3.3	36.0	15,774.9	3,155	7.1

¤) Based on wake reduced results and any curtailments.

Calculated Annual Energy for each of 15 new WTGs with total 75.0 MW rated power

Links	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Result [MWh/y]	Wake loss [%]	Free mean wind speed [m/s]
1 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,831.1	3.1	7.06
2 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,599.0	4.7	7.07
3 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,534.7	5.0	7.06
4 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,509.9	5.1	7.06
5 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,497.9	4.9	7.06
6 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,528.4	4.6	7.05
7 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,507.2	4.5	7.04
8 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,958.4	1.9	7.05
9 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	16,041.0	1.9	7.06
10 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	16,016.0	2.2	7.07
11 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,946.5	2.4	7.06
12 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,893.1	2.4	7.05
13 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,897.6	2.3	7.05
14 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	15,861.2	2.2	7.04
15 A	Yes	Siemens Gamesa	SG 5.0-145 MkII-5,000	5,000	145.0	102.5	EMD	AM 0, 5.0MW - 1.225kg/m3	16,001.2	1.7	7.05

Annual Energy results includes shown losses. For expected NET AEP (expected sold production), see report Loss & Uncertainty.

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5/5/2023 10:58 AM/3.6.361

PARK - Main Result

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01

WTG siting

UTM (north)-WGS84 Zone: 31

		Easting	Northing	Z [m]	Row data/Description
1	New	400,079.00	3,118,990.00	603.6	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (16)
2	New	400,747.00	3,117,868.00	608.6	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (17)
3	New	401,376.00	3,116,808.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (18)
4	New	401,931.00	3,115,739.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (19)
5	New	402,504.00	3,114,671.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (20)
6	New	403,166.00	3,113,615.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (21)
7	New	403,898.00	3,112,547.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (22)
8	New	404,562.00	3,111,460.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (23)
9	New	401,142.00	3,118,731.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (24)
10	New	401,884.00	3,117,665.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (25)
11	New	402,494.00	3,116,604.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (26)
12	New	403,004.00	3,115,544.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (27)
13	New	403,614.00	3,114,455.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (28)
14	New	404,268.00	3,113,337.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (29)
15	New	404,904.00	3,112,288.00	610.0	Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! hub: 102.5 m (TOT: 175.0 m) (30)

Project:

ARGEL-TFMJUAN

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Calculated:

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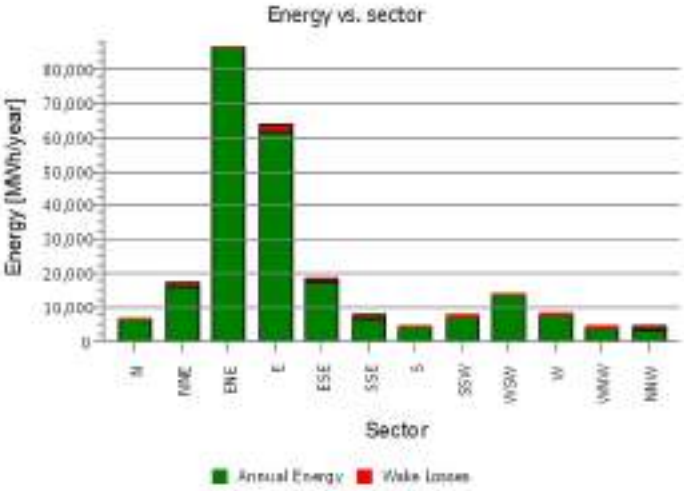
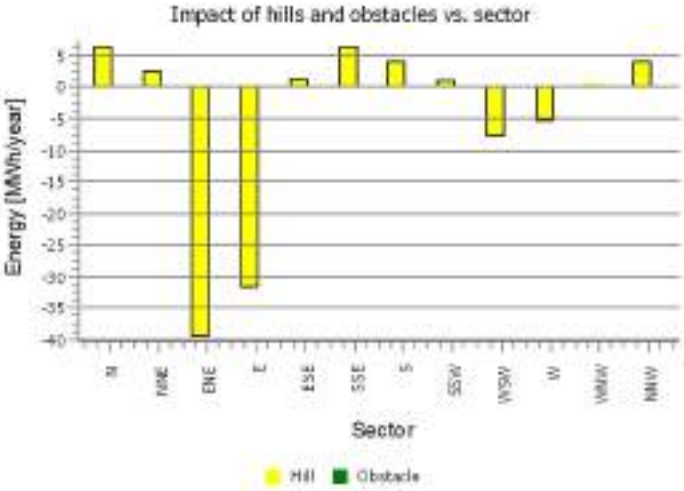
PARK - Production Analysis

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01 WTG: All new WTGs, Air density 1.097 kg/m³

Directional Analysis

Sector		0 N	1 NNE	2 ENE	3 E	4 ESE	5 SSE	6 S	7 SSW	8 WSW	9 W	10 WNW	11 NNW	Total
Roughness based energy	[MWh]	6,955.8	17,257.4	86,701.8	63,950.3	18,368.2	7,808.0	4,724.7	7,994.6	14,200.8	8,296.2	4,211.3	4,205.1	244,674.1
+Increase due to hills	[MWh]	6.5	2.5	-39.5	-31.5	1.3	6.4	4.0	1.1	-7.8	-5.2	0.4	3.9	-57.8
-Decrease due to wake losses	[MWh]	258.2	1,278.0	104.5	2,163.1	823.9	1,246.1	155.9	546.9	22.4	397.2	223.4	773.6	7,993.3
Resulting energy	[MWh]	6,704.0	15,981.9	86,557.8	61,755.7	17,545.6	6,568.3	4,572.9	7,448.8	14,170.6	7,893.8	3,988.3	3,435.4	236,623.1
Specific energy	[kWh/m²]													955
Specific energy	[kWh/kW]													3,155
Increase due to hills	[%]	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	-0.1	-0.1	0.0	0.1	-0.02
Decrease due to wake losses	[%]	3.7	7.4	0.1	3.4	4.5	15.9	3.3	6.8	0.2	4.8	5.3	18.4	3.27
Utilization	[%]	42.7	39.3	40.8	40.5	42.1	36.0	40.4	37.9	43.4	42.6	41.9	36.1	40.6
Operational	[Hours/year]	471	784	2,253	1,571	727	481	330	346	551	428	321	364	8,627
Full Load Equivalent	[Hours/year]	89	213	1,154	823	234	88	61	99	189	105	53	46	3,155





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PARK - Power Curve Analysis

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01 WTG: 1 - Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O!, Hub height: 102.5 m

Name: AM 0, 5.0MW - 1.225kg/m3
Source: GD411360 R2-SG 5.0-145 POWER CURVE.pdf

Source/Date	Created by	Created	Edited	Stop wind speed [m/s]	Power control	CT curve type	Generator type	Specific power kW/m²
1/24/2020	EMD	1/24/2020	6/17/2020	27.0	Pitch	User defined	Variable	0.30

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HP curve comparison - Note: For standard air density

Vmean	[m/s]	5	6	7	8	9	10
HP value Pitch, variable speed (2013)	[MWh]	8,391	12,775	17,009	20,777	23,952	26,489
Siemens Gamesa SG 5.0-145 MkII 5000 145.0 !O! AM 0, 5.0MW - 1.225kg/m3	[MWh]	8,628	13,069	17,324	21,082	24,234	26,755
Check value	[%]	-3	-2	-2	-1	-1	-1

The table shows comparison between annual energy production calculated on basis of simplified "HP-curves" which assume that all WTGs performs quite similar - only specific power loading (kW/m^2) and single/dual speed or stall/pitch decides the calculated values. Productions are without wake losses.
For further details, ask at the Danish Energy Agency for project report J.nr. 51171/00-0016 or see the windPRO manual.
The method is refined in EMD report "20 Detailed Case Studies comparing Project Design Calculations and actual Energy Productions for Wind Energy Projects worldwide", jan 2003.
Use the table to evaluate if the given power curve is reasonable - if the check value are lower than -5%, the power curve probably is too optimistic due to uncertainty in power curve measurement.

Power curve

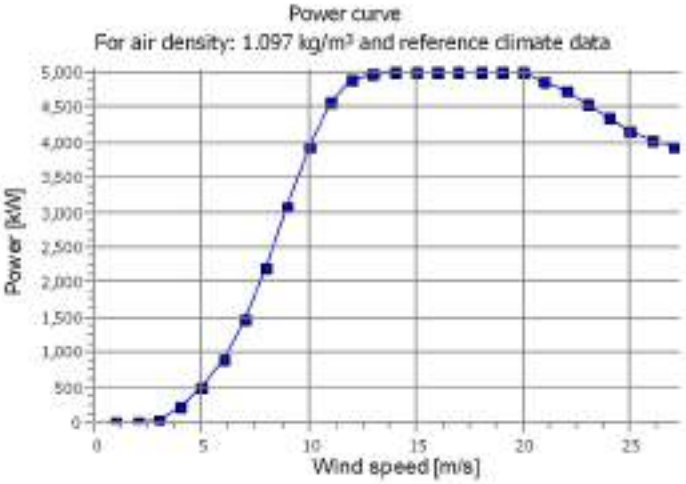
Original data, Air density: 1.225 kg/m³

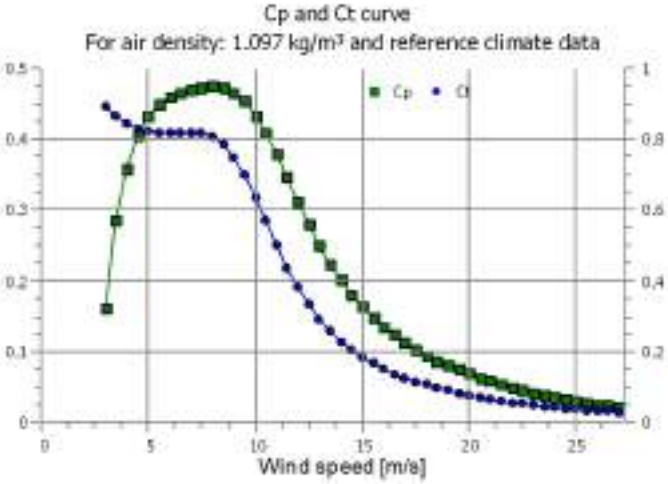
Wind speed [m/s]	Power [kW]	Cp	Wind speed [m/s]	Ct curve
3.0	56.0	0.21	3.0	0.89
3.5	130.0	0.30	3.5	0.87
4.0	241.0	0.37	4.0	0.84
4.5	383.0	0.42	4.5	0.83
5.0	555.0	0.44	5.0	0.82
5.5	762.0	0.45	5.5	0.82
6.0	1,009.0	0.46	6.0	0.82
6.5	1,300.0	0.47	6.5	0.82
7.0	1,638.0	0.47	7.0	0.82
7.5	2,026.0	0.47	7.5	0.82
8.0	2,462.0	0.48	8.0	0.81
8.5	2,934.0	0.47	8.5	0.79
9.0	3,421.0	0.46	9.0	0.75
9.5	3,887.0	0.45	9.5	0.70
10.0	4,294.0	0.42	10.0	0.64
10.5	4,611.0	0.39	10.5	0.57
11.0	4,829.0	0.36	11.0	0.50
11.5	4,942.0	0.32	11.5	0.44
12.0	4,978.0	0.28	12.0	0.38
12.5	4,990.0	0.25	12.5	0.33
13.0	4,995.0	0.22	13.0	0.29
13.5	4,998.0	0.20	13.5	0.26
14.0	4,999.0	0.18	14.0	0.23
14.5	4,999.0	0.16	14.5	0.20
15.0	5,000.0	0.15	15.0	0.18
15.5	5,000.0	0.13	15.5	0.17
16.0	5,000.0	0.12	16.0	0.15
16.5	5,000.0	0.11	16.5	0.14
17.0	5,000.0	0.10	17.0	0.13
17.5	5,000.0	0.09	17.5	0.11
18.0	4,999.0	0.08	18.0	0.11
18.5	4,996.0	0.08	18.5	0.10
19.0	4,990.0	0.07	19.0	0.09
19.5	4,978.0	0.07	19.5	0.08
20.0	4,956.0	0.06	20.0	0.08
20.5	4,920.0	0.06	20.5	0.07
21.0	4,869.0	0.05	21.0	0.07
21.5	4,802.0	0.05	21.5	0.06
22.0	4,720.0	0.04	22.0	0.06
22.5	4,628.0	0.04	22.5	0.05
23.0	4,531.0	0.04	23.0	0.05
23.5	4,432.0	0.03	23.5	0.04
24.0	4,338.0	0.03	24.0	0.04
24.5	4,247.0	0.03	24.5	0.04
25.0	4,169.0	0.03	25.0	0.04
25.5	4,096.0	0.02	25.5	0.03
26.0	4,031.0	0.02	26.0	0.03
26.5	3,978.0	0.02	26.5	0.03
27.0	3,930.0	0.02	27.0	0.03

Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.097 kg/m³ New windPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

Wind speed [m/s]	Power [kW]	Cp	Interval [m/s]	Energy [MWh]	Acc.Energy [MWh]	Relative [%]
1.0	0.0	0.00	0.50- 1.50	0.0	0.0	0.0
2.0	0.0	0.00	1.50- 2.50	0.0	0.0	0.0
3.0	39.5	0.16	2.50- 3.50	31.7	31.7	0.2
4.0	207.9	0.36	3.50- 4.50	168.5	200.2	1.3
5.0	490.9	0.43	4.50- 5.50	485.5	685.7	4.3
6.0	898.6	0.46	5.50- 6.50	1,030.1	1,715.8	10.8
7.0	1,461.7	0.47	6.50- 7.50	1,785.3	3,501.1	22.1
8.0	2,200.9	0.47	7.50- 8.50	2,595.6	6,096.7	38.5
9.0	3,074.6	0.47	8.50- 9.50	3,104.8	9,201.5	58.1
10.0	3,932.7	0.43	9.50-10.50	2,928.8	12,130.3	76.6
11.0	4,567.3	0.38	10.50-11.50	2,081.8	14,212.1	89.8
12.0	4,892.6	0.31	11.50-12.50	1,078.0	15,290.2	96.6
13.0	4,981.5	0.25	12.50-13.50	402.1	15,692.3	99.1
14.0	4,995.4	0.20	13.50-14.50	109.9	15,802.2	99.8
15.0	4,999.0	0.16	14.50-15.50	23.4	15,825.5	100.0
16.0	4,999.9	0.13	15.50-16.50	4.4	15,829.9	100.0
17.0	5,000.0	0.11	16.50-17.50	0.9	15,830.8	100.0
18.0	5,000.0	0.09	17.50-18.50	0.2	15,831.0	100.0
19.0	4,999.5	0.08	18.50-19.50	0.0	15,831.0	100.0
20.0	4,994.0	0.07	19.50-20.50	0.0	15,831.0	100.0
21.0	4,869.0	0.06	20.50-21.50	0.0	15,831.0	100.0
22.0	4,720.0	0.05	21.50-22.50	0.0	15,831.0	100.0
23.0	4,531.0	0.04	22.50-23.50	0.0	15,831.0	100.0
24.0	4,338.0	0.03	23.50-24.50	0.0	15,831.0	100.0
25.0	4,169.0	0.03	24.50-25.50	0.0	15,831.0	100.0
26.0	4,031.0	0.03	25.50-26.50	0.0	15,831.0	100.0
27.0	3,930.0	0.02	26.50-27.50	0.0	15,831.0	100.0





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PARK - Terrain

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01 Site Data: A - Site data: WAsP (5)

Obstacles:

0 Obstacles used

Roughness:

Terrain data files used in calculation:
C:\Users\Enerland\Documents\WindPRO Data\Projects\ARGEL-TFMJUAN\ROUGHNESSLINE_ARGEL-TFMJUAN_0.wpo
Min X: 371,647, Max X: 432,722, Min Y: 3,085,962, Max Y: 3,145,146, Width: 61,075 m, Height: 59,184 m

Orography:

Terrain data files used in calculation:
C:\Users\Enerland\Documents\WindPRO Data\Projects\ARGEL-TFMJUAN\CONTOURLINE_ONLINEDATA_0.wpo
Min X: 392,160, Max X: 412,450, Min Y: 3,105,750, Max Y: 3,125,404, Width: 20,290 m, Height: 19,654 m

Project:
ARGEL-TFMJUAN

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Calculated:
5/5/2023 10:58 AM/3.6.361

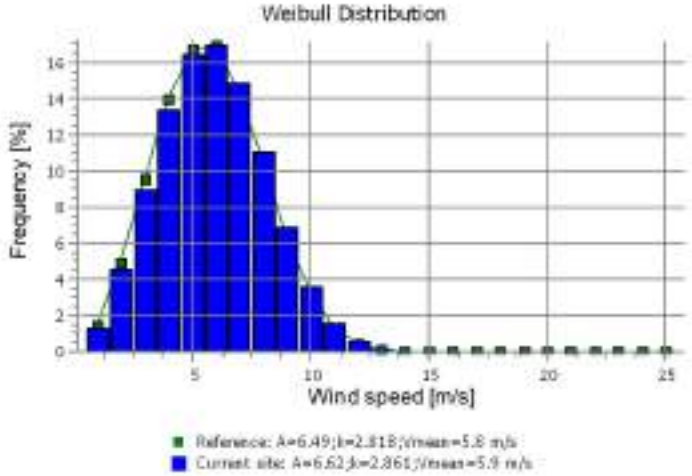
PARK - Wind Data Analysis

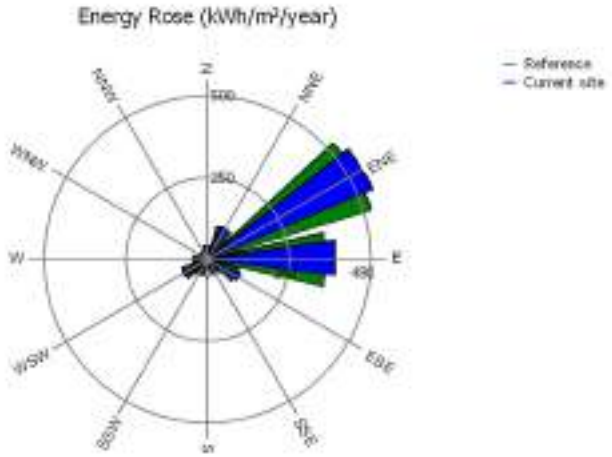
Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01 Wind data: A - Site data: WAsP (5); Hub height: 50.0

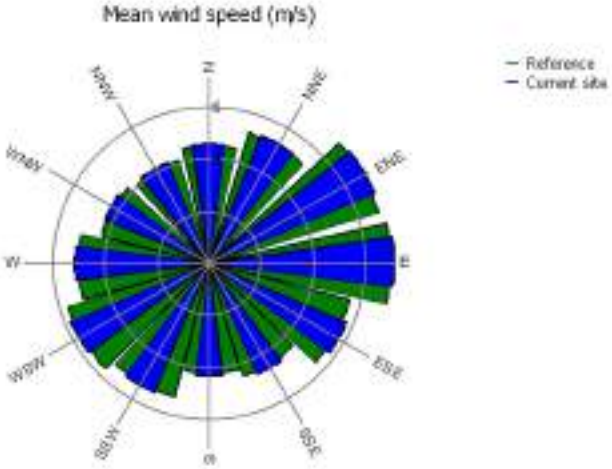
Site coordinates
UTM (north)-WGS84 Zone: 31
East: 402,297.28 North: 3,115,622.92
Wind statistics
DZ CERRA_N28.161557_E002.004104 (2) - 150.00 m.wws

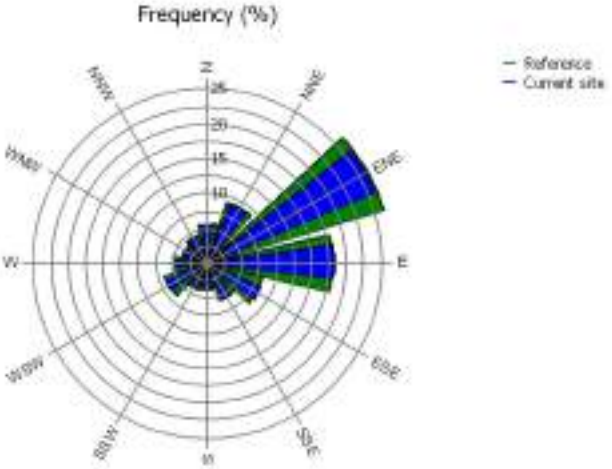
Weibull Data

	Current site				Reference: Roughness class 1		
Sector	A-parameter [m/s]	Wind speed [m/s]	k-parameter	Frequency [%]	A-parameter [m/s]	k-parameter	Frequency [%]
0 N	5.15	4.57	2.541	5.4	5.07	2.541	5.5
1 NNE	5.96	5.29	2.561	9.1	5.88	2.564	9.2
2 ENE	7.62	6.88	3.799	26.1	7.48	3.807	26.5
3 E	7.75	7.07	4.459	18.2	7.60	4.482	18.0
4 ESE	6.38	5.72	3.232	8.4	6.18	3.197	8.2
5 SSE	5.23	4.63	2.232	5.6	5.08	2.201	5.5
6 S	4.86	4.31	1.955	3.8	4.76	1.943	3.8
7 SSW	6.05	5.36	2.346	4.0	5.97	2.365	4.0
8 WSW	6.42	5.74	3.104	6.4	6.30	3.115	6.4
9 W	5.76	5.15	2.998	5.0	5.62	2.998	4.9
10 WNW	4.91	4.36	2.428	3.7	4.79	2.412	3.7
11 NNW	4.71	4.18	2.447	4.2	4.62	2.447	4.2
All	6.62	5.90	2.861	100.0	6.49	2.818	100.0









Project:
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Calculated:
5/5/2023 10:58 AM/3.6.361

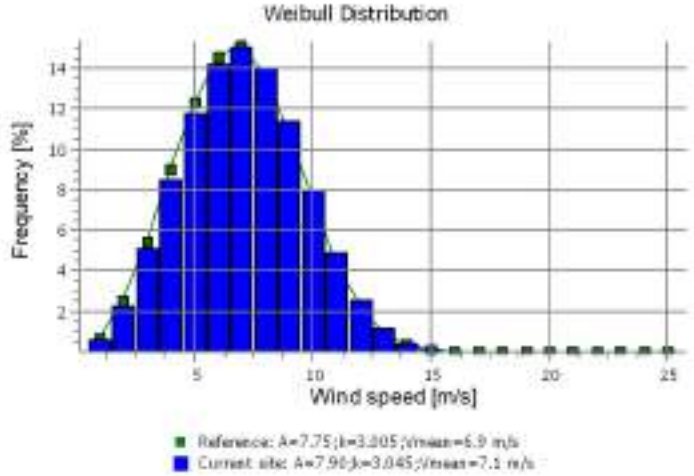
PARK - Wind Data Analysis

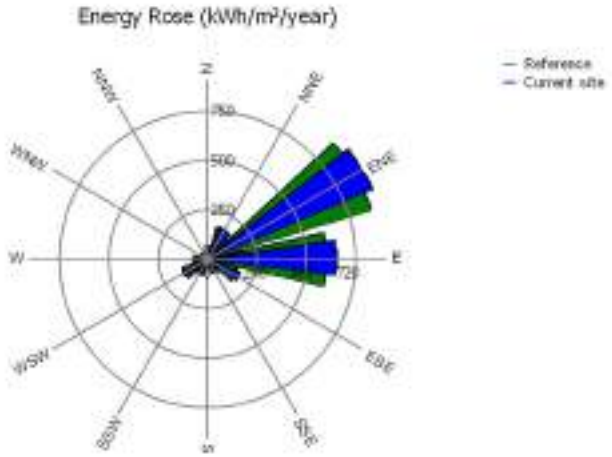
Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01 Wind data: A - Site data: WAsP (5); Hub height: 102.5

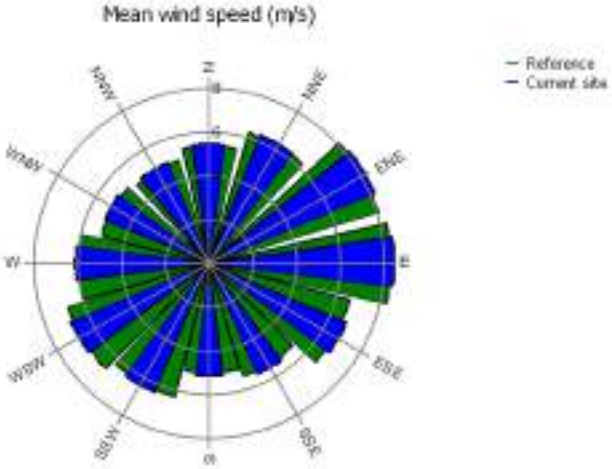
Site coordinates
UTM (north)-WGS84 Zone: 31
East: 402,297.28 North: 3,115,622.92
Wind statistics
DZ CERRA_N28.161557_E002.004104 (2) - 150.00 m.wws

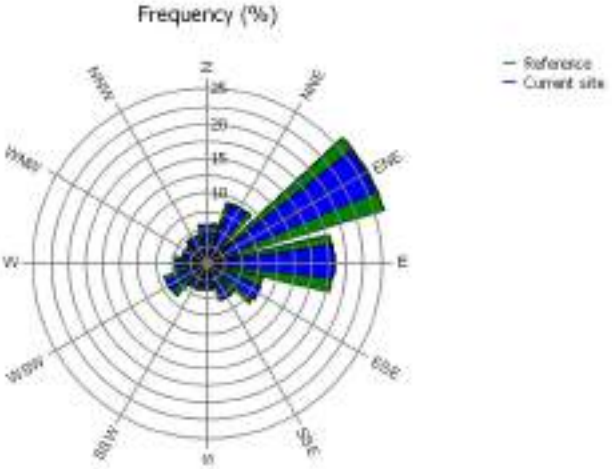
Weibull Data

	Current site				Reference: Roughness class 1		
Sector	A-parameter [m/s]	Wind speed [m/s]	k-parameter	Frequency [%]	A-parameter [m/s]	k-parameter	Frequency [%]
0 N	6.15	5.47	2.756	5.4	6.05	2.759	5.5
1 NNE	7.12	6.34	2.775	9.1	7.02	2.787	9.2
2 ENE	9.08	8.24	4.115	26.1	8.91	4.132	26.5
3 E	9.24	8.46	4.826	18.2	9.05	4.862	18.0
4 ESE	7.61	6.84	3.510	8.4	7.37	3.473	8.2
5 SSE	6.25	5.54	2.424	5.6	6.08	2.393	5.5
6 S	5.82	5.16	2.119	3.8	5.71	2.112	3.8
7 SSW	7.23	6.42	2.549	4.0	7.13	2.568	4.0
8 WSW	7.66	6.88	3.373	6.4	7.51	3.383	6.4
9 W	6.87	6.16	3.252	5.0	6.70	3.259	4.9
10 WNW	5.87	5.22	2.635	3.7	5.72	2.619	3.7
11 NNW	5.63	5.01	2.658	4.2	5.52	2.662	4.2
All	7.90	7.06	3.045	100.0	7.75	3.005	100.0









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PARK - Wind Data Analysis

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Site coordinates
UTM (north)-WGS84 Zone: 31
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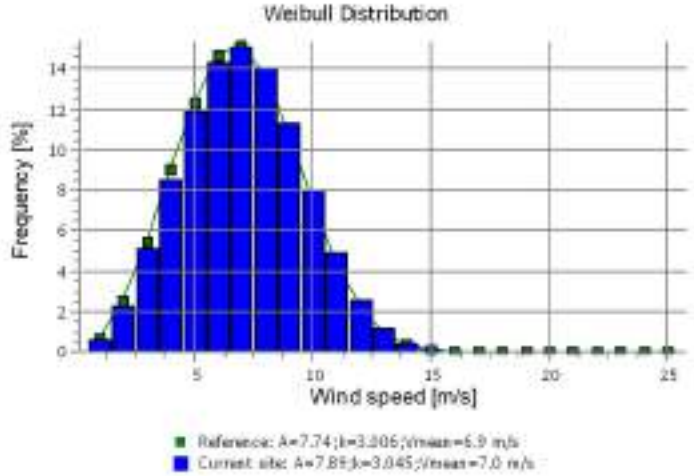
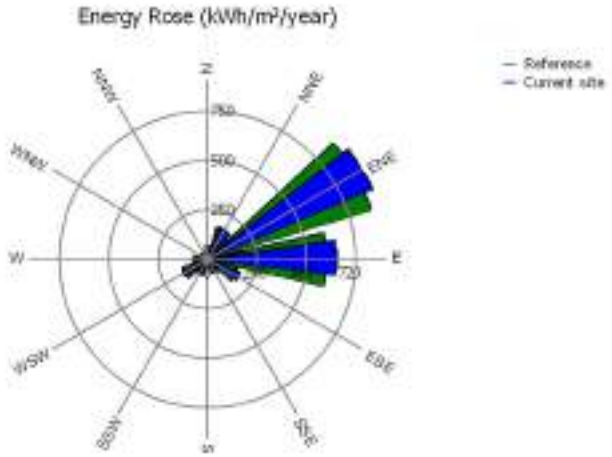
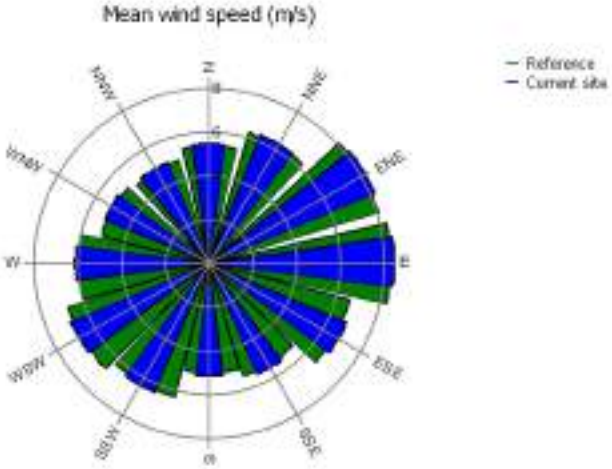
Wind statistics
DZ CERRA_N28.161557_E002.004104 (2) - 150.00 m.wws

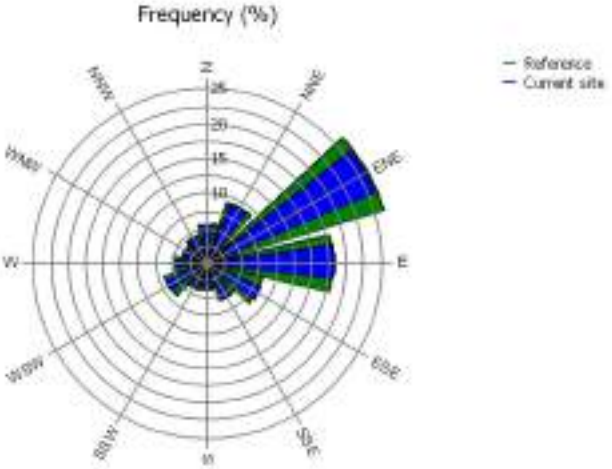
Weibull Data

	Current site				Reference: Roughness class 1			
Sector	A-parameter [m/s]	Wind speed [m/s]	k-parameter	Frequency [%]	A-parameter [m/s]	k-parameter	Frequency [%]
0 N	6.14	5.46	2.756	5.4	6.04	2.760	5.5
1 NNE	7.11	6.33	2.779	9.1	7.01	2.788	9.2
2 ENE	9.06	8.23	4.119	26.1	8.89	4.134	26.5
3 E	9.22	8.45	4.826	18.2	9.04	4.863	18.0
4 ESE	7.59	6.83	3.510	8.4	7.36	3.474	8.2
5 SSE	6.24	5.53	2.424	5.6	6.07	2.393	5.5
6 S	5.81	5.15	2.119	3.8	5.70	2.113	3.8
7 SSW	7.22	6.41	2.549	4.0	7.12	2.569	4.0
8 WSW	7.65	6.87	3.373	6.4	7.50	3.384	6.4
9 W	6.86	6.15	3.256	5.0	6.69	3.260	4.9
10 WNW	5.86	5.21	2.639	3.7	5.71	2.620	3.7
11 NNW	5.62	5.00	2.662	4.2	5.51	2.663	4.2
All	7.89	7.05	3.045	100.0	7.74	3.006	100.0









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Calculated:
5/5/2023 10:58 AM/3.6.361

PARK - Park power curve

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01

Wind speed [m/s]	Power Free WTGs [kW]	Park WTGs [kW]	N [kW]	NNE [kW]	ENE [kW]	E [kW]	ESE [kW]	SSE [kW]	S [kW]	SSW [kW]	WSW [kW]	W [kW]	WNW [kW]	NNW [kW]
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.5	1,659	1,496	1,544	1,372	1,653	1,499	1,496	1,093	1,544	1,372	1,653	1,499	1,496	1,093
4.5	5,027	4,677	4,766	4,417	5,014	4,679	4,662	3,838	4,765	4,417	5,014	4,679	4,662	3,836
5.5	10,151	9,551	9,699	9,101	10,128	9,556	9,523	8,122	9,698	9,101	10,128	9,556	9,523	8,119
6.5	17,375	16,396	16,639	15,653	17,336	16,401	16,347	14,089	16,639	15,653	17,336	16,401	16,348	14,085
7.5	27,121	25,635	26,012	24,517	27,062	25,636	25,569	22,126	26,012	24,518	27,062	25,636	25,570	22,122
8.5	39,400	37,432	37,972	35,970	39,326	37,459	37,392	32,580	37,973	35,971	39,326	37,459	37,393	32,570
9.5	52,752	50,748	51,388	49,319	52,687	50,836	50,810	45,335	51,388	49,319	52,687	50,836	50,810	45,328
10.5	64,348	62,912	63,425	61,948	64,310	63,034	63,025	58,648	63,424	61,947	64,310	63,034	63,025	58,655
11.5	71,483	70,847	71,100	70,423	71,465	70,915	70,926	68,856	71,100	70,423	71,465	70,915	70,926	68,868
12.5	74,351	74,217	74,295	74,116	74,349	74,231	74,257	73,760	74,296	74,115	74,349	74,231	74,256	73,765
13.5	74,865	74,848	74,856	74,835	74,864	74,849	74,851	74,798	74,856	74,835	74,864	74,849	74,851	74,798
14.5	74,971	74,967	74,968	74,964	74,970	74,967	74,967	74,955	74,968	74,964	74,970	74,967	74,967	74,955
15.5	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985	74,985
16.5	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
17.5	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
18.5	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
19.5	74,967	74,970	74,969	74,971	74,967	74,970	74,970	74,976	74,969	74,971	74,967	74,970	74,970	74,976
20.5	73,800	73,981	73,961	74,102	73,808	73,977	74,010	74,382	73,962	74,102	73,808	73,977	74,012	74,387
21.5	72,030	72,077	72,062	72,110	72,032	72,075	72,076	72,199	72,062	72,110	72,032	72,075	72,076	72,199
22.5	69,420	69,477	69,459	69,518	69,422	69,475	69,476	69,627	69,459	69,518	69,422	69,475	69,476	69,627
23.5	66,480	66,535	66,518	66,575	66,482	66,533	66,534	66,679	66,518	66,575	66,482	66,533	66,534	66,679
24.5	63,705	63,750	63,736	63,783	63,706	63,749	63,750	63,870	63,736	63,783	63,707	63,749	63,750	63,870
25.5	61,440	61,473	61,463	61,497	61,441	61,472	61,473	61,560	61,463	61,497	61,441	61,472	61,473	61,560
26.5	59,670	59,692	59,685	59,709	59,671	59,691	59,692	59,751	59,685	59,709	59,671	59,691	59,692	59,751
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description:
The park power curve is similar to a WTG power curve, meaning that when a given wind speed appears in front of the park with same speed in the entire wind farm area (before influence from the park), the output from the park can be found in the park power curve. Another way to say this: The park power curve includes wake losses, but do NOT include terrain given variations in the wind speed over the park area.
Measuring a park power curve is not as simple as measuring a WTG power curve due to the fact that the park power curve depends on the wind direction and that the same wind speed normally will not appear for the entire park area at the same time (only in very flat non-complex terrain). The idea with this version of the park power curve is not to use it for validation based on measurements. This would require at least 2 measurement masts at two sides of the park, unless only a few direction sectors should be tested, AND non complex terrain (normally only useable off shore). Another park power curve version for complex terrain is available in windPRO.

The park power curve can be used for:

1. Forecast systems, based on more rough (approximated) wind data, the park power curve would be an efficient way to make the connection from wind speed (and direction) to power.
2. Construction of duration curves, telling how often a given power output will appear, the park power curve can be used together with the average wind distribution for the Wind farm area in hub height. The average wind distribution can eventually be obtained based on the Weibull parameters for each WTG position. These are found at print menu: >Result to file< in the >Park result< which can be saved to file or copied to clipboard and pasted in Excel.
3. Calculation of wind energy index based on the PARK production (see below).
4. Estimation of the expected PARK production for an existing wind farm based on wind measurements at minimum 2 measurement masts at two sides of wind farm. The masts must be used for obtaining the free wind speed. The free wind speed is used in the simulation of expected energy production with the PARK power curve. This procedure will only work suitable in non complex terrains. For complex terrain another park power curve calculation is available in windPRO (PPV-model).

Note:
From the >Result to file< the >Wind Speeds Inside Wind farm< is also available. These can (e.g. via Excel) be used for extracting the wake induced reductions in measured wind speed.

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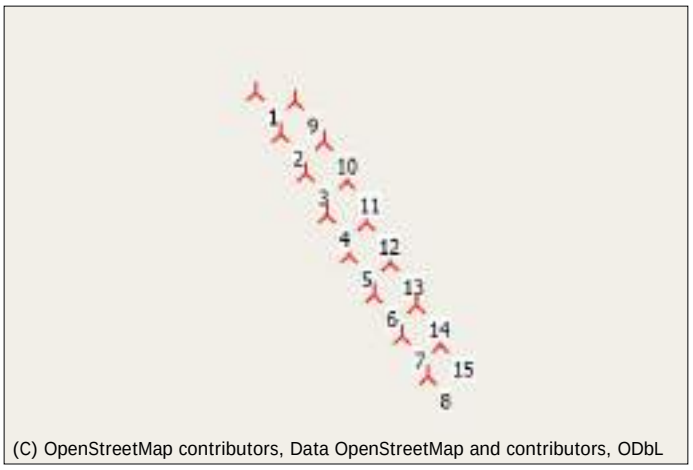
Calculated:
5/5/2023 10:58 AM/3.6.361

PARK - WTG distances

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01

WTG distances

	Z [m]	Nearest WTG	Z [m]	Horizontal distance [m]	Distance in rotor diameters
1	603.6	9	610.0	1,094	7.5
2	608.6	9	610.0	949	6.5
3	610.0	10	610.0	996	6.9
4	610.0	11	610.0	1,032	7.1
5	610.0	12	610.0	1,006	6.9
6	610.0	13	610.0	952	6.6
7	610.0	14	610.0	872	6.0
8	610.0	15	610.0	896	6.2
9	610.0	2	608.6	949	6.5
10	610.0	3	610.0	996	6.9
11	610.0	4	610.0	1,032	7.1
12	610.0	5	610.0	1,006	6.9
13	610.0	6	610.0	952	6.6
14	610.0	7	610.0	872	6.0
15	610.0	8	610.0	896	6.2
Min	603.6		608.6	872	6.0
Max	610.0		610.0	1,094	7.5



Scale 1:200,000

New WTG

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Calculated:
5/5/2023 10:58 AM/3.6.361

PARK - Wind statistics info

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01

Main data for wind statistic

File	C:\Users\Enerland\Documents\WindPRO Data\Projects\ARGEL-TFMJUAN\DZ CERRA_N28.161557_E002.004104 (2) - 150.00 m.wws
Name	CERRA_N28.161557_E002.004104 (2) - 150.00 m
Country	Algeria
Source	USER
Mast coordinates	UTM (north)-WGS84 Zone: 31 East: 402,224.67 North: 3,115,500.15
Created	4/11/2023
Edited	4/11/2023
Sectors	12
WAsP version	WAsP 12 Version 12.07.0056
Coordinate system	UTM (north)-WGS84 Zone: 31
Displacement height	None

Additional info for wind statistic

Source data	CERRA_N28.161557_E002.004104 (2)
Data from	1/1/1999
Data to	1/1/2021
Measurement length	264.0 Months
Recovery rate	100.0 %
Effective measurement length	264.0 Months

Note

To get the most correct calculation results, wind statistics shall be calculated with the SAME model and model parameters, as currently chosen in calculation. For WAsP versions before 10.0, the model is unchanged, but thereafter more model changes affecting the wind statistic is seen. Likewise WAsP CFD should always use WAsP CFD calculated wind statistics.

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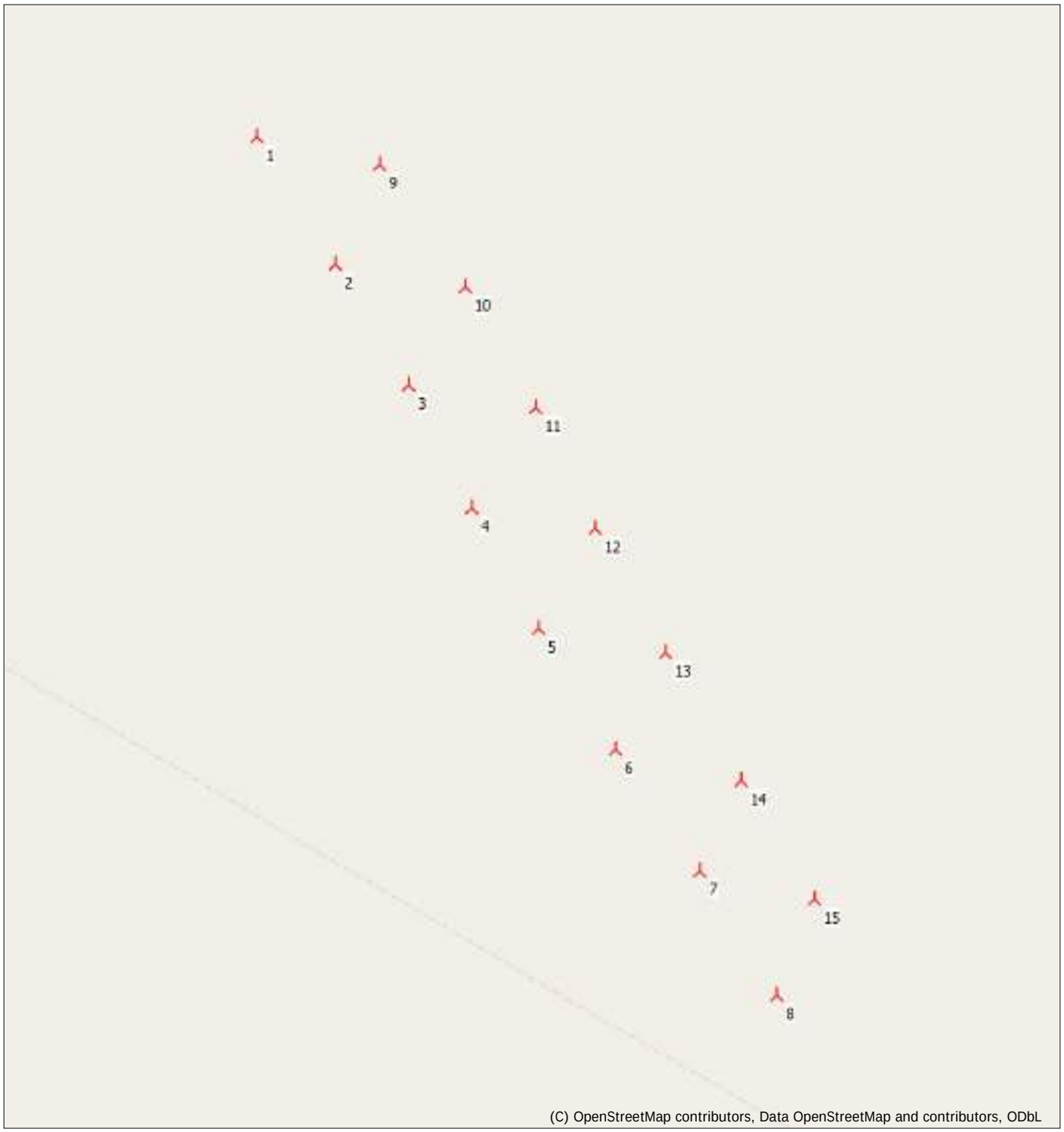
Calculated:
5/5/2023 10:58 AM/3.6.361

PARK - Map

Calculation: TFM_JUAN_LAZARO_SG145_5.0 MW_REV01



0 500 1000 1500 2000 m

Map: EMD OpenStreetMap , Print scale 1:50,000, Map center UTM (north)-WGS84 Zone: 31 East: 402,491.50 North: 3,115,225.00

New WTG