

# **Site Assessment Report**

Energy Yield Estimation

**Wind farm:  
Ascog Farm (GB)**

**3 x E-44 900kW with 45m hh**

## Imprint

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Project:

**Ascog Farm**

Description:

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## PARK - Main Result

**Calculation:** Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hh

### Wake Model

N.O. Jensen (RISØ/EMD)

#### Calculation Settings

Air density calculation mode Individual per WTG  
 Result for WTG at hub altitude 1.235 kg/m³ to 1.238 kg/m³  
 Air density relative to standard 100.8 % to 101.0 %  
 Hub altitude above sea level (asl) 121.4 m to 145.0 m  
 Annual mean temperature at hub alt. 7.7 °C to 7.9 °C  
 Pressure at WTGs 995.6 hPa to 998.4 hPa

#### Wake Model Parameters

| From angle [°] | To angle [°] | Terrain type | Wake Decay Constant |
|----------------|--------------|--------------|---------------------|
| 345.0          | 15.0         |              | 0.089               |
| 15.0           | 45.0         |              | 0.078               |
| 45.0           | 75.0         |              | 0.051               |
| 75.0           | 105.0        |              | 0.059               |
| 105.0          | 135.0        |              | 0.053               |
| 135.0          | 165.0        |              | 0.062               |
| 165.0          | 195.0        |              | 0.070               |
| 195.0          | 225.0        |              | 0.061               |
| 225.0          | 255.0        |              | 0.057               |
| 255.0          | 285.0        |              | 0.065               |
| 285.0          | 315.0        |              | 0.086               |
| 315.0          | 345.0        |              | 0.084               |

#### Wake calculation settings

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

#### Wind statistics

GB Ascog WMM (Wind Index MCP using MERRA\_basic\_W04.665\_nob.u00).wms

#### WASP version

WASP 6-9 2.8.579



## Key results for height 50.0 m above ground level

### Terrain BN (AIRY) (Normal)

| East | North   | Name of wind distribution | Type                | Wind energy [kWh/m²]    | Mean wind speed [m/s] | Equivalent roughness |      |
|------|---------|---------------------------|---------------------|-------------------------|-----------------------|----------------------|------|
| A    | 210,080 | 663,449                   | Ascog Farm PARK TDO | WASP (WASP 6-9 2.8.579) | 5,185                 | 7.9                  | -0.2 |

## Calculated Annual Energy for Wind Farm

| WTG combination | Result PARK [MWh/y] | Result-12.0% [MWh] | GROSS (no loss) Free WTGs [MWh/y] | Park efficiency [%] | Specific results <sup>a)</sup> |                         |                              |                                   |
|-----------------|---------------------|--------------------|-----------------------------------|---------------------|--------------------------------|-------------------------|------------------------------|-----------------------------------|
|                 |                     |                    |                                   |                     | Capacity factor [%]            | Mean WTG result [MWh/y] | Full load hours [Hours/year] | Mean wind speed @hub height [m/s] |
| Wind farm       | 7,371.0             | 6,486.5            | 7,512.4                           | 98.1                | 27.4                           | 2,162.2                 | 2,402                        | 7.6                               |

<sup>a)</sup> Based on Result-12.0%

## Calculated Annual Energy for each of 3 new WTGs with total 2.7 MW rated power

| WTG type | Terrain | Valid | Manufact.    | Type-generator | Power, rated [kW] | Rotor diameter [m] | Hub height [m] | Power curve Creator | Name        | Annual Energy Result [MWh] | Result-12.0% [MWh] | Park Efficiency [%] | Mean wind speed [m/s] |
|----------|---------|-------|--------------|----------------|-------------------|--------------------|----------------|---------------------|-------------|----------------------------|--------------------|---------------------|-----------------------|
|          |         |       |              |                |                   |                    |                |                     |             |                            |                    |                     |                       |
| 1        | A       | Yes   | ENERCON GmbH | E-44-900       | 900               | 44.0               | 45.0           | USER                | Power curve | 2,597.0                    | 2,285              | 97.40               | 7.87                  |
| 2        | A       | Yes   | ENERCON GmbH | E-44-900       | 900               | 44.0               | 45.0           | USER                | Power curve | 2,464.5                    | 2,169              | 97.52               | 7.63                  |
| 3        | A       | Yes   | ENERCON GmbH | E-44-900       | 900               | 44.0               | 45.0           | USER                | Power curve | 2,309.5                    | 2,032              | 99.60               | 7.28                  |

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**PARK - Main Result****Calculation:** Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hh**WTG siting****BN (AIRY) (Normal)**

|       | BN (AIRY) (Normal) |         | Z<br>[m] | Row data/Description   |
|-------|--------------------|---------|----------|--|
|       | East               | North   |          |  |
| 1 New | 210,043            | 663,535 | 100.0    | ENERCON GmbH E-44 900 44.0 !O! hub: 45.0 m (TOT: 67.0 m) (1) |
| 2 New | 210,063            | 663,365 | 90.5     | ENERCON GmbH E-44 900 44.0 !O! hub: 45.0 m (TOT: 67.0 m) (2) |
| 3 New | 210,063            | 663,185 | 76.4     | ENERCON GmbH E-44 900 44.0 !O! hub: 45.0 m (TOT: 67.0 m) (3) |

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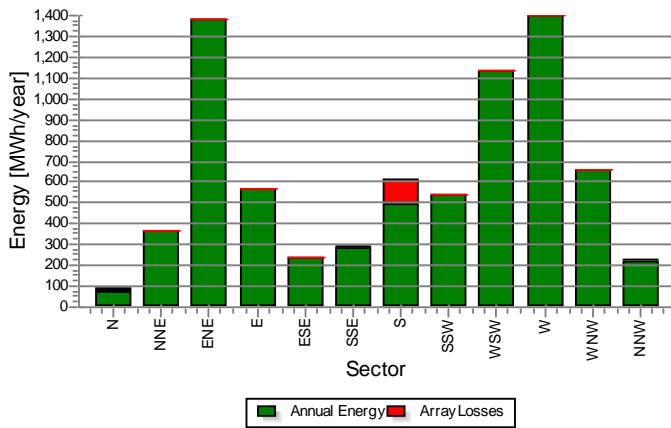
## PARK - Production Analysis

Calculation: Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hhWTG: All new WTGs, Air density varies with WTG position 1.235 kg/m<sup>3</sup> - 1.238 kg/m<sup>3</sup>

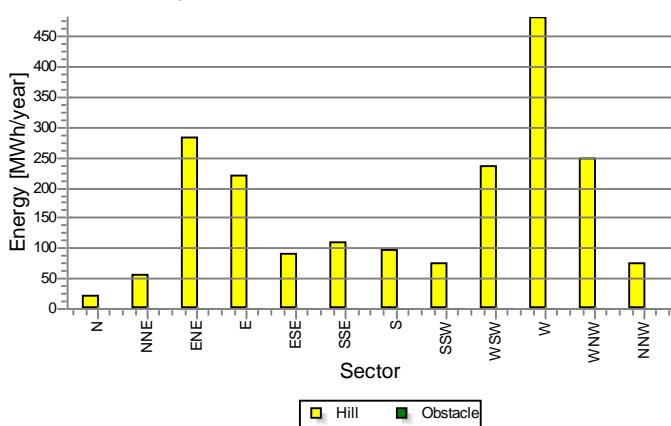
### Directional Analysis

| 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]          | 66.2        | 309.9        | 1,101.2        | 350.6        | 145.1        | 182.4        | 512.1        | 469.7        | 899.5          | 918.9          | 407.6        | 149.6        | 5,512.6        |
| +Increase due to hills [MWh]          | 22.7        | 57.3         | 283.9          | 219.1        | 92.1         | 108.9        | 97.0         | 74.4         | 237.7          | 482.2          | 248.5        | 76.0         | 1,999.7        |
| -Decrease due to array losses [MWh]   | 16.7        | 0.2          | 0.0            | 0.0          | 0.0          | 5.9          | 112.7        | 0.1          | 0.0            | 0.0            | 0.0          | 5.7          | 141.3          |
| <b>Resulting energy [MWh]</b>         | <b>72.2</b> | <b>366.9</b> | <b>1,385.1</b> | <b>569.6</b> | <b>237.2</b> | <b>285.3</b> | <b>496.4</b> | <b>544.0</b> | <b>1,137.2</b> | <b>1,401.1</b> | <b>656.1</b> | <b>219.8</b> | <b>7,371.0</b> |
| Specific energy [kWh/m <sup>2</sup> ] |             |              |                |              |              |              |              |              |                |                |              |              | 1,616          |
| Specific energy [kWh/kW]              |             |              |                |              |              |              |              |              |                |                |              |              | 2,730          |
| Increase due to hills [%]             | 34.3        | 18.5         | 25.8           | 62.5         | 63.5         | 59.7         | 18.9         | 15.8         | 26.4           | 52.5           | 61.0         | 50.8         | 36.28          |
| Decrease due to array losses [%]      | 18.8        | 0.0          | 0.0            | 0.0          | 0.0          | 2.0          | 18.5         | 0.0          | 0.0            | 0.0            | 0.0          | 2.5          | 1.88           |
| Utilization [%]                       | 36.8        | 36.4         | 32.8           | 34.0         | 39.3         | 37.2         | 28.4         | 33.1         | 31.0           | 34.1           | 39.8         | 44.1         | 33.8           |
| Operational [Hours/year]              | 295         | 537          | 1,254          | 643          | 383          | 440          | 640          | 515          | 908            | 1,261          | 839          | 503          | 8,218          |
| Full Load Equivalent [Hours/year]     | 27          | 136          | 513            | 211          | 88           | 106          | 184          | 201          | 421            | 519            | 243          | 81           | 2,730          |

Energy vs. sector



Impact of hills and obstacles vs. sector



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### PARK - Power Curve Analysis

**Calculation:** Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hhWTG: 1 - ENERCON GmbH E-44 900 44.0 IO! Power curve Guar. 3.0, Hub height: 45.0 m

**Name:** Power curve Guar. 3.0

**Source:** ENERCON GmbH

| Source/Date                    | Created by | Created    | Edited     | Stop wind speed [m/s] | Power control | CT curve type | Generator type | Specific power kW/m <sup>2</sup> |
|--------------------------------|------------|------------|------------|-----------------------|---------------|---------------|----------------|----------------------------------|
| 2009-11-25                     | USER       | 2005-07-25 | 2010-03-03 | 25.0                  | Pitch         | User defined  | Variable       | 0.59                             |
| Ct-curve Rev. 3.0 (03.03.2010) |            |            |            |                       |               |               |                |                                  |

#### Power curve

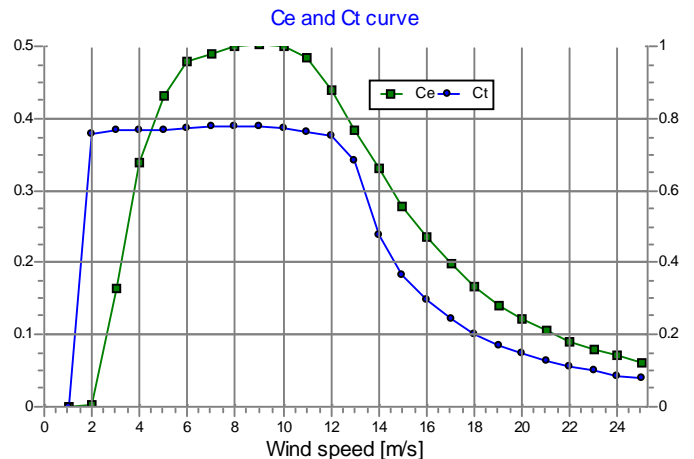
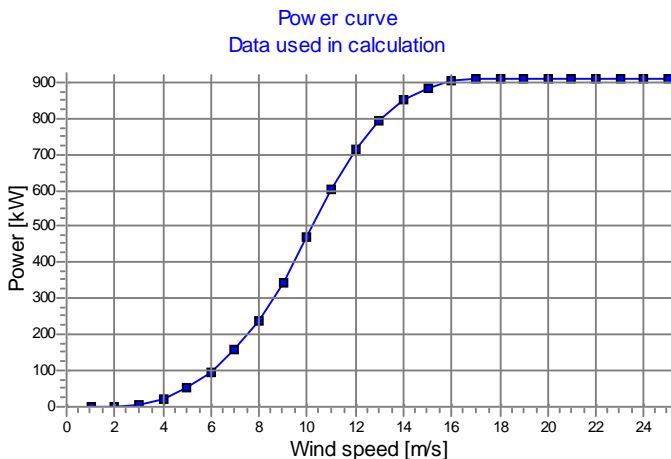
Original data from Windcat, Air density: 1.225 kg/m<sup>3</sup>

| Wind speed [m/s] | Power [kW] | Ce   | Wind speed [m/s] | Ct curve |
|------------------|------------|------|------------------|----------|
| 1.0              | 0.0        | 0.00 | 1.0              | 0.00     |
| 2.0              | 0.0        | 0.00 | 2.0              | 0.76     |
| 3.0              | 4.0        | 0.16 | 3.0              | 0.77     |
| 4.0              | 20.0       | 0.34 | 4.0              | 0.77     |
| 5.0              | 50.0       | 0.43 | 5.0              | 0.77     |
| 6.0              | 96.0       | 0.48 | 6.0              | 0.77     |
| 7.0              | 156.0      | 0.49 | 7.0              | 0.78     |
| 8.0              | 238.0      | 0.50 | 8.0              | 0.78     |
| 9.0              | 340.0      | 0.50 | 9.0              | 0.78     |
| 10.0             | 466.0      | 0.50 | 10.0             | 0.77     |
| 11.0             | 600.0      | 0.48 | 11.0             | 0.76     |
| 12.0             | 710.0      | 0.44 | 12.0             | 0.75     |
| 13.0             | 790.0      | 0.39 | 13.0             | 0.69     |
| 14.0             | 850.0      | 0.33 | 14.0             | 0.47     |
| 15.0             | 880.0      | 0.28 | 15.0             | 0.37     |
| 16.0             | 905.0      | 0.24 | 16.0             | 0.29     |
| 17.0             | 910.0      | 0.20 | 17.0             | 0.24     |
| 18.0             | 910.0      | 0.17 | 18.0             | 0.20     |
| 19.0             | 910.0      | 0.14 | 19.0             | 0.17     |
| 20.0             | 910.0      | 0.12 | 20.0             | 0.15     |
| 21.0             | 910.0      | 0.11 | 21.0             | 0.13     |
| 22.0             | 910.0      | 0.09 | 22.0             | 0.11     |
| 23.0             | 910.0      | 0.08 | 23.0             | 0.10     |
| 24.0             | 910.0      | 0.07 | 24.0             | 0.09     |
| 25.0             | 910.0      | 0.06 | 25.0             | 0.08     |

#### Power, Efficiency and energy vs. wind speed

Data used in calculation, Air density: 1.235 kg/m<sup>3</sup> New WindPRO method (adjusted IEC method, improved to match turbine control) <RECOMMENDED>

| Wind speed [m/s] | Power [kW] | Ce   | 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     | 0.5          | 0.5               | 0.0          |
| 3.0              | 4.1        | 0.16 | 2.50- 3.50     | 4.6          | 5.1               | 0.2          |
| 4.0              | 20.3       | 0.34 | 3.50- 4.50     | 17.4         | 22.5              | 0.9          |
| 5.0              | 50.6       | 0.43 | 4.50- 5.50     | 42.8         | 65.3              | 2.5          |
| 6.0              | 96.9       | 0.48 | 5.50- 6.50     | 80.2         | 145.6             | 5.6          |
| 7.0              | 157.5      | 0.49 | 6.50- 7.50     | 126.8        | 272.4             | 10.5         |
| 8.0              | 240.1      | 0.50 | 7.50- 8.50     | 178.6        | 450.9             | 17.4         |
| 9.0              | 343.2      | 0.50 | 8.50- 9.50     | 229.8        | 680.7             | 26.2         |
| 10.0             | 470.2      | 0.50 | 9.50-10.50     | 272.0        | 952.7             | 36.7         |
| 11.0             | 604.4      | 0.48 | 10.50-11.50    | 293.4        | 1,246.1           | 48.0         |
| 12.0             | 713.8      | 0.44 | 11.50-12.50    | 286.5        | 1,532.6           | 59.0         |
| 13.0             | 793.1      | 0.38 | 12.50-13.50    | 257.1        | 1,789.6           | 68.9         |
| 14.0             | 851.7      | 0.33 | 13.50-14.50    | 215.8        | 2,005.4           | 77.2         |
| 15.0             | 881.5      | 0.28 | 14.50-15.50    | 171.5        | 2,176.9           | 83.8         |
| 16.0             | 905.3      | 0.24 | 15.50-16.50    | 130.5        | 2,307.5           | 88.8         |
| 17.0             | 910.0      | 0.20 | 16.50-17.50    | 95.5         | 2,402.9           | 92.5         |
| 18.0             | 910.0      | 0.17 | 17.50-18.50    | 67.5         | 2,470.5           | 95.1         |
| 19.0             | 910.0      | 0.14 | 18.50-19.50    | 46.5         | 2,517.0           | 96.9         |
| 20.0             | 910.0      | 0.12 | 19.50-20.50    | 31.3         | 2,548.3           | 98.1         |
| 21.0             | 910.0      | 0.10 | 20.50-21.50    | 20.5         | 2,568.8           | 98.9         |
| 22.0             | 910.0      | 0.09 | 21.50-22.50    | 13.1         | 2,582.0           | 99.4         |
| 23.0             | 910.0      | 0.08 | 22.50-23.50    | 8.2          | 2,590.2           | 99.7         |
| 24.0             | 910.0      | 0.07 | 23.50-24.50    | 5.0          | 2,595.2           | 99.9         |
| 25.0             | 910.0      | 0.06 | 24.50-25.50    | 1.9          | 2,597.0           | 100.0        |



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## PARK - Wind Data Analysis

**Calculation:** Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hhWind data: A - Ascog Farm PARK TDO; Hub height: 50.0

### Site coordinates

BN (AIRY) (Normal) East: 210,080 North: 663,449

### Wind statistics

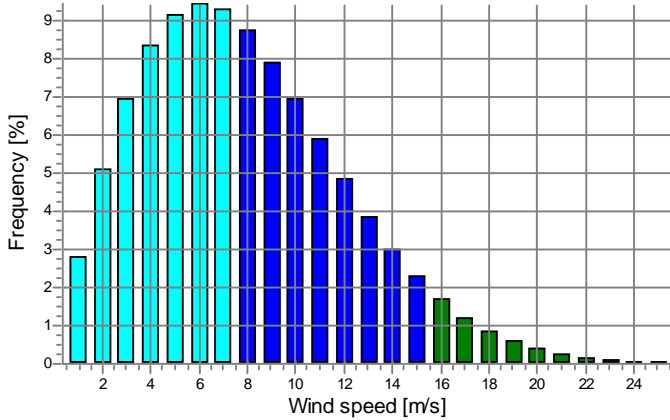
GB Ascog WMM (Wind Index MCP using MERRA\_basic\_W04.665\_N56.000).wws

### Weibull Data

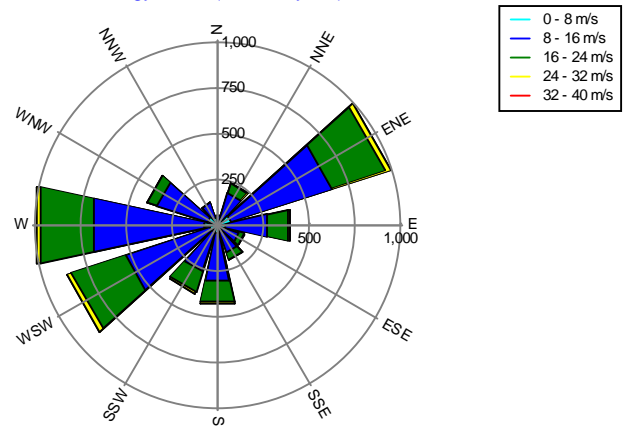
#### Current site

| Sector | A- parameter [m/s] | Wind speed [m/s] | k- parameter | Frequency [%] |
|--------|--------------------|------------------|--------------|---------------|
| 0 N    | 5.55               | 4.93             | 1.842        | 3.6           |
| 1 NNE  | 7.56               | 6.73             | 1.732        | 6.5           |
| 2 ENE  | 9.82               | 8.70             | 2.084        | 15.1          |
| 3 E    | 8.70               | 7.73             | 1.854        | 7.9           |
| 4 ESE  | 7.30               | 6.50             | 1.783        | 4.7           |
| 5 SSE  | 7.59               | 6.76             | 1.779        | 5.5           |
| 6 S    | 9.21               | 8.16             | 2.045        | 7.8           |
| 7 SSW  | 9.68               | 8.57             | 2.068        | 6.2           |
| 8 WSW  | 10.63              | 9.42             | 2.201        | 10.9          |
| 9 W    | 10.01              | 8.86             | 2.197        | 15.3          |
| 10 WNW | 8.30               | 7.36             | 2.092        | 10.3          |
| 11 NNW | 6.72               | 5.95             | 2.080        | 6.2           |
| All    | 8.90               | 7.89             | 1.936        | 100.0         |

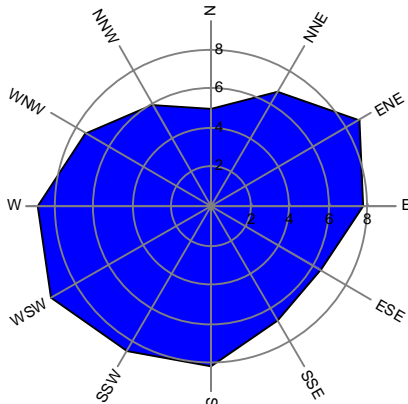
Weibull Distribution



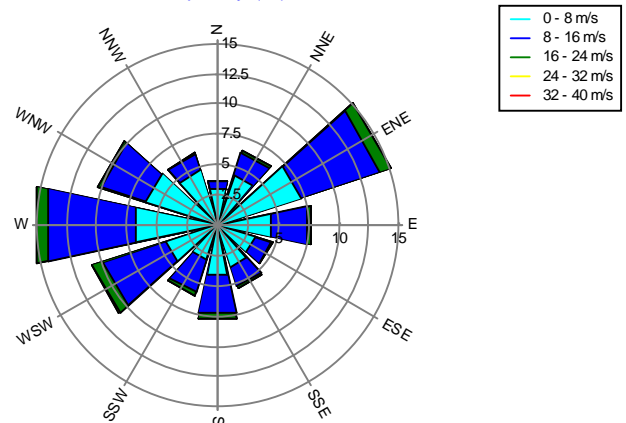
Energy Rose (kWh/m²/year)



Mean wind speed (m/s)



Frequency (%)



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## PARK - Park power curve

Calculation: Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hh

| Wind speed<br>[m/s] | Power             |                   |           |             |             |           |             |             |           |             |             |           |             |             |  |
|---------------------|-------------------|-------------------|-----------|-------------|-------------|-----------|-------------|-------------|-----------|-------------|-------------|-----------|-------------|-------------|--|
|                     | Free WTGs<br>[kW] | Park WTGs<br>[kW] | N<br>[kW] | NNE<br>[kW] | ENE<br>[kW] | E<br>[kW] | ESE<br>[kW] | SSE<br>[kW] | S<br>[kW] | SSW<br>[kW] | WSW<br>[kW] | W<br>[kW] | WNW<br>[kW] | NNW<br>[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                 | 6                 | 6                 | 3         | 6           | 6           | 6         | 6           | 6           | 3         | 6           | 6           | 6         | 6           | 6           |  |
| 3.5                 | 36                | 35                | 23        | 36          | 36          | 36        | 36          | 35          | 23        | 36          | 36          | 36        | 36          | 35          |  |
| 4.5                 | 106               | 102               | 75        | 106         | 106         | 106       | 106         | 103         | 73        | 106         | 106         | 106       | 106         | 102         |  |
| 5.5                 | 221               | 213               | 162       | 221         | 221         | 221       | 221         | 215         | 157       | 221         | 221         | 221       | 221         | 214         |  |
| 6.5                 | 381               | 369               | 286       | 381         | 381         | 381       | 381         | 371         | 278       | 381         | 381         | 381       | 381         | 370         |  |
| 7.5                 | 596               | 577               | 451       | 596         | 596         | 596       | 596         | 580         | 440       | 596         | 596         | 596       | 596         | 578         |  |
| 8.5                 | 874               | 847               | 665       | 874         | 875         | 875       | 875         | 852         | 649       | 875         | 875         | 875       | 875         | 849         |  |
| 9.5                 | 1,220             | 1,183             | 935       | 1,220       | 1,221       | 1,221     | 1,221       | 1,190       | 911       | 1,221       | 1,221       | 1,221     | 1,221       | 1,186       |  |
| 10.5                | 1,614             | 1,567             | 1,254     | 1,614       | 1,615       | 1,615     | 1,615       | 1,577       | 1,223     | 1,615       | 1,615       | 1,615     | 1,615       | 1,572       |  |
| 11.5                | 1,980             | 1,929             | 1,591     | 1,980       | 1,981       | 1,981     | 1,981       | 1,943       | 1,549     | 1,981       | 1,981       | 1,981     | 1,981       | 1,939       |  |
| 12.5                | 2,263             | 2,217             | 1,919     | 2,263       | 2,264       | 2,264     | 2,264       | 2,233       | 1,868     | 2,263       | 2,264       | 2,264     | 2,264       | 2,231       |  |
| 13.5                | 2,470             | 2,439             | 2,241     | 2,471       | 2,471       | 2,471     | 2,471       | 2,453       | 2,195     | 2,471       | 2,471       | 2,471     | 2,471       | 2,451       |  |
| 14.5                | 2,601             | 2,586             | 2,494     | 2,601       | 2,601       | 2,601     | 2,601       | 2,594       | 2,466     | 2,601       | 2,601       | 2,601     | 2,601       | 2,593       |  |
| 15.5                | 2,682             | 2,676             | 2,637     | 2,683       | 2,683       | 2,683     | 2,683       | 2,679       | 2,626     | 2,683       | 2,683       | 2,683     | 2,683       | 2,678       |  |
| 16.5                | 2,724             | 2,721             | 2,707     | 2,724       | 2,724       | 2,724     | 2,724       | 2,723       | 2,702     | 2,724       | 2,724       | 2,724     | 2,724       | 2,723       |  |
| 17.5                | 2,730             | 2,730             | 2,729     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,728     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 18.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 19.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 20.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 21.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 22.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 23.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 24.5                | 2,730             | 2,730             | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       | 2,730     | 2,730       | 2,730       |  |
| 25.5                | 0                 | 0                 | 0         | 0           | 0           | 0         | 0           | 0           | 0         | 0           | 0           | 0         | 0           | 0           |  |
| 26.5                | 0                 | 0                 | 0         | 0           | 0           | 0         | 0           | 0           | 0         | 0           | 0           | 0         | 0           | 0           |  |
| 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 array 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:

- 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.
- 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.
- Calculation of wind energy index based on the PARK production (see below).
- 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.



Project:

**Ascog Farm**

E\_2013\_037

Description:

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Dreekamp 5

DE-26605 Aurich

04941/927-0

Sinead Reilly

Calculated:

2013-04-22 13:15/2.8.579

### PARK - WTG distances

Calculation: Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hh

#### WTG distances

|            | Z            | Nearest WTG | Z            | Horizontal distance | Distance in rotor diameters |
|------------|--------------|-------------|--------------|---------------------|-----------------------------|
|            | [m]          |             | [m]          | [m]                 |                             |
| 1          | 100.0        | 2           | 90.5         | 171                 | 3.9                         |
| 2          | 90.5         | 1           | 100.0        | 171                 | 3.9                         |
| 3          | 76.4         | 2           | 90.5         | 180                 | 4.1                         |
| <b>Min</b> | <b>76.4</b>  |             | <b>90.5</b>  | <b>171</b>          | <b>3.9</b>                  |
| <b>Max</b> | <b>100.0</b> |             | <b>100.0</b> | <b>180</b>          | <b>4.1</b>                  |



New WTG

Scale 1:20,000

Project:

**Ascog Farm**

Description:

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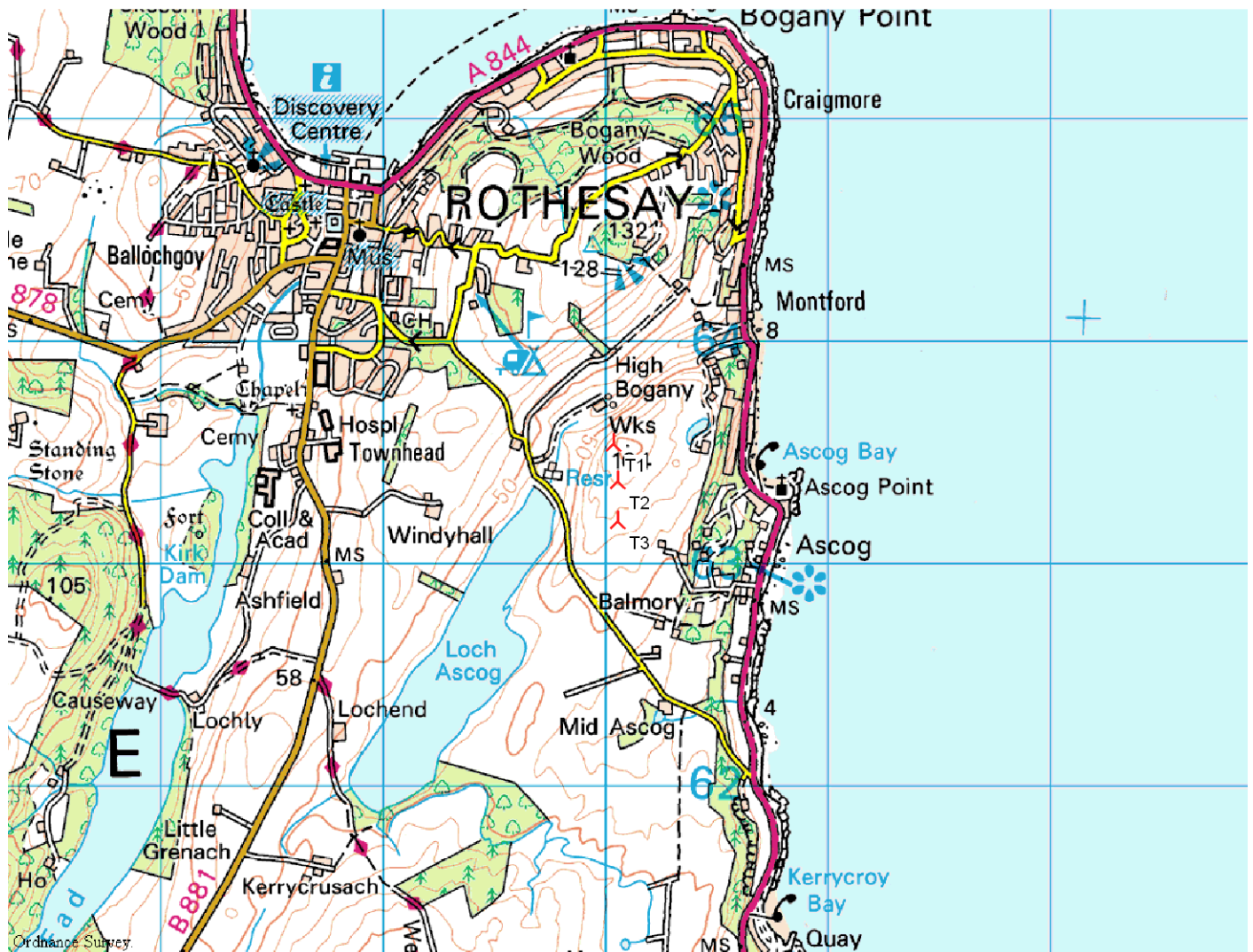
Sinead Reilly

Calculated:

2013-04-22 13:15/2.8.579

### PARK - Map

**Calculation:** Energy Yield Estimation: 3 x ENERCON E-44 900kW with 45m hh



Map: WindPRO map , Print scale 1:30,000, Map center BN (AIRY) (Normal) East: 210,053 North: 663,360

New WTG

**Special notes and disclaimer:****Energy yield estimations with met masts**

The energy yield was estimated using wind data achieved by wind measurements. The wind data was long-term correlated by means of MERRA reanalysis data (provided by EMD). The modelled wind conditions of the WEC locations have been transferred from the met mast using WAsP.

The annual energy production (AEP) is measured at the WEC reference point (at the 400V AC terminals behind the power cabinets). The AEP takes wake losses into account. If not expressly stated below, any other losses were not considered (e.g. electrical losses after WEC reference point, losses due to lack of availability or operation outside design parameters, blade icing events, grid curtailment, noise or shadow shut-downs or sector management, etc.). For the definition of wind class the air density of the site has to be taken into account.

**Note:** Energy yield estimations are affected by uncertainties (in the calculation model or in the information on landscape roughness and obstacles or due to inaccuracy of available maps). Therefore, it is strongly recommended to apply the safety margin as stated in the report.

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