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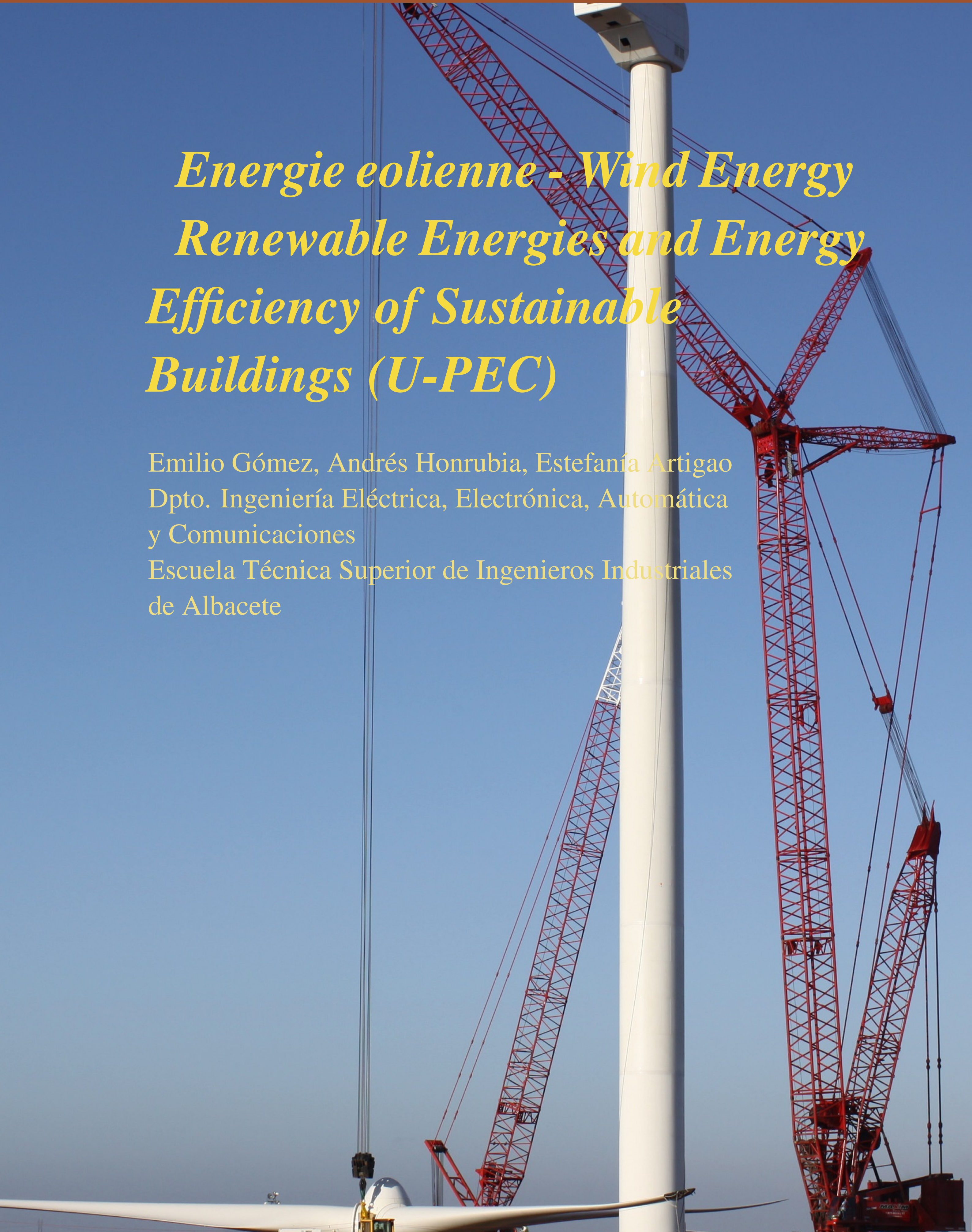

Energie eolienne - Wind Energy Renewable Energies and Energy Efficiency of Sustainable Buildings (U-PEC)

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1 — Wind Resource

1.1 Weibull Distribution

This practical exercise proposes to estimate the wind resource at a site. To this end, the students are provided with two data sets: `Site1.csv` and `Site2.csv`. Both data sets contain wind speeds at 20 m height measured at two different sites.

1) Estimate the wind speeds at the hub-height (80 m) for both sites and different terrain types, as proposed in the following scenarios. Represent the results jointly and explain.

   - Site 1, using the power law, eq (1.1), for a terrain defined as *Smooth hard ground, calm water*.
   - Site 1, using the power law, eq (1.1), for a terrain defined as *Small town with trees and shrubs*.
   - Site 1, using the logarithmic law, eq (1.2), for a terrain defined as *Water surface*.
   - Site 1, using the logarithmic law, eq (1.2), for a terrain defined as *Urban districts and farm land with many windbreaks*.
   - Site 2, using the power law, eq (1.1), for a terrain defined as *Smooth hard ground, calm water*.
   - Site 2, using the power law, eq (1.1), for a terrain defined as *Small town with trees and shrubs*.
   - Site 2, using the logarithmic law, eq (1.2), for a terrain defined as *Water surface*.
   - Site 2, using the logarithmic law, eq (1.2), for a terrain defined as *Urban districts and farm land with many windbreaks*.

Terrain Characteristics	Friction Coefficient α
Smooth hard ground, calm water	*0.10*
Tall grass on level ground	*0.15*
High crops, hedges and shrubs	*0.20*
Wooded countryside, many trees	*0.25*
Small town with trees and shrubs	*0.30*
Large city with tall buildings	*0.30*

Table 1.1: Shear exponent, α [**Renewable-Efficient-PS:2004:Masters**]

Terrain Characteristics	Roughness Length z
Water surface	*0.0002*
Open areas with a few windbreaks	*0.03*
Farm land with some windbreaks more than 1 km apart	*0.1*
Urban districts and farm land with many windbreaks	*0.4*
Dense urban or forest	*1.6*

Table 1.2: Roughness length, z [**Renewable-Efficient-PS:2004:Masters**]

$$\frac{v}{v_0} = \left(\frac{H}{H_0}\right)^{\alpha} \tag{1.1}$$

$$\frac{v}{v_0} = \frac{ln\frac{H}{z}}{ln\frac{H_0}{z}} \tag{1.2}$$

2) Adjust the wind distributions obtained in the previous exercise for wind speeds at 80 m using the logarithmic law in water surface, for both sites, to the Weibull distribution. Indicate the scale and shape parameters obtained. Represent jointly the estimated data vs the adjusted curve.

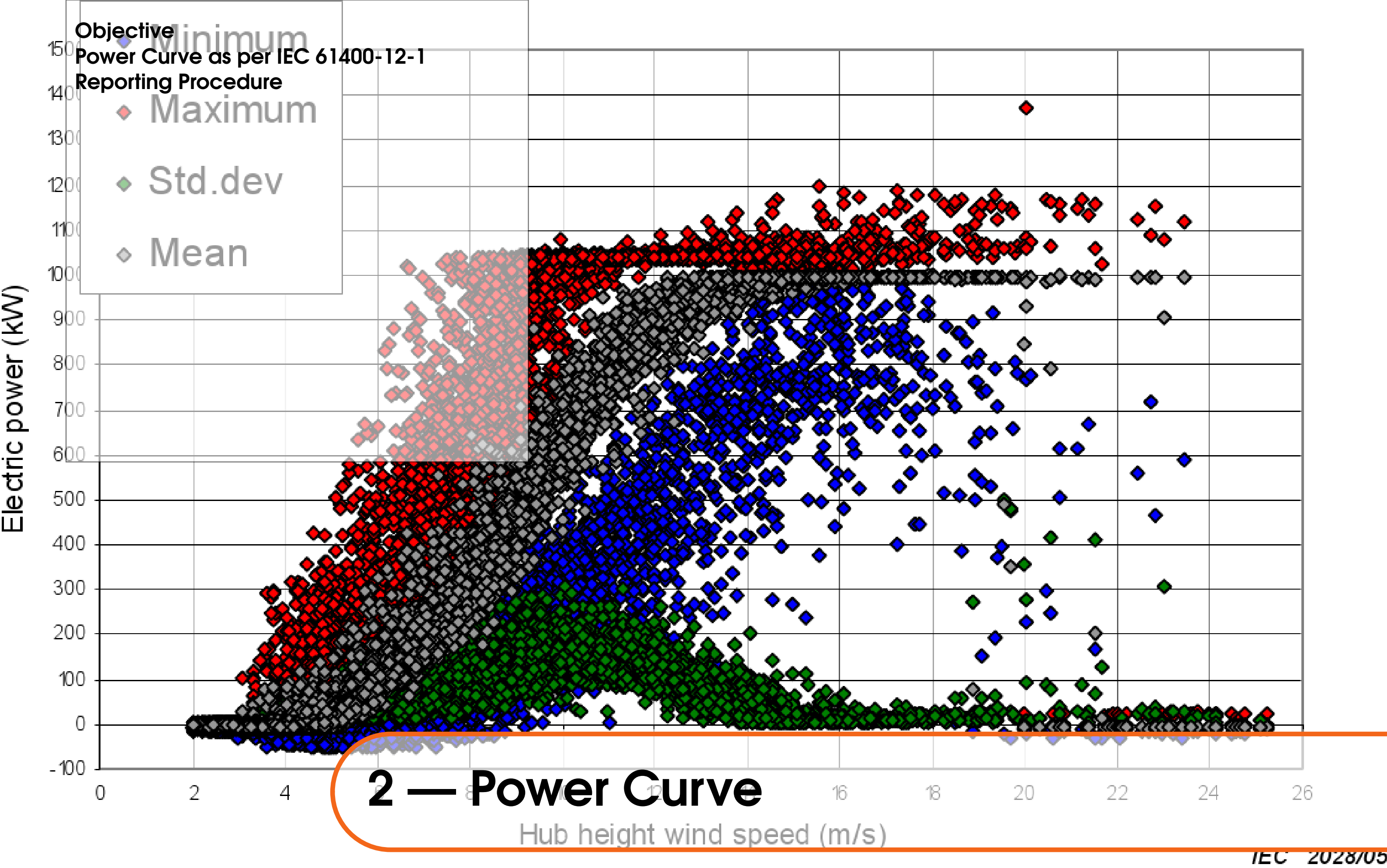
1.2 Annual Energy Production

This practical exercise proposes to estimate the Annual Energy Production (AEP) if the Siemens-Gamesa wind turbine SWT-2.3-82 with 80 m hub-height was installed at calm water site, given the wind speed data sets `Site1.csv` and `Site2.csv` (as before).

3) Find the power curve for the SWT-2.3-82 wind turbine. Adjust the curve in Matlab using splines. Represent jointly the raw power curve values with the adjusted curve and with the wind data set and adjusted Weibull curve for Site 1. Repeat for Site 2.

4) Estimate the AEP, CF and EFLH using the Weibull fit for Site 1 and Site 2.

5) Estimate the AEP, CF and EFLH using the discrete wind data for Site 1 and Site 2.



2 — Power Curve

2.1 Objective

The power curve of a wind turbine will be estimated in this practice session. The guidelines established by the International Standard IEC 61400-12-1 will be implemented. Specifically, the following material will be used:

- Software GNU Octave, or Mathworks MATLAB®.
- Measured data from power curve testing.
- IEC 61400-12-1.

2.2 Power Curve as per IEC 61400-12-1

Given the file with data measured from the wind turbine: `fichero_ws_pa10min.csv`

1) Calculate the power curve of the wind turbine considering a cut-in wind speed of 4 $\frac{m}{s}$.

2) Adjust with splines the power curve of the wind turbine. Compare the adjusted curve with the original data. In order to obtain the power production values with the adjusted curve, the following command could be used: `ppval(Curva1_splines,v)`

3) Check if the data series used is enough according to the requirements of the Standard.

2.3 Reporting Procedure

The following instructions should be followed:

- Both, the report and the required scripts from Octave, or Mathworks MATLAB®, should be provided.