PO. 252

LIFE CYCLE ASSESMENT OF A FRENCH WIND PLANT

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Introduction

VALEOL-VALOREM has contracted **RESCOLL** to carry out a **Life Cycle Assessment (LCA)** of a **French onshore wind plant** comprised of five 3.0 MW wind turbines.

This study is a valuable tool in the approach of VALEOL-VALOREM to managing their environmental impact and their continuous improvement

LCA prepared in accordance with ISO 14040 and ISO 14044 et based on:

- data related to a **French test wind plant**.
- **all stages** of life cycle (study stage, production of all parts of the wind plant, transportation, construction stage, wind plant operations including maintenance, disassembly and end of life treatment of turbines)

The wind plant **construction stage** has been described in **detail** as it concerns directly the profession of VALEOL-VALOREM. The most characteristic of the test wind plant is the use of **concrete towers**.

Goal, scope and background

The main **objectives** of this study:

- Deliver a rigorous and impartial **environmental assessment** of the **wind plant** in Pauillac, **France**.
- Describe the most favourable stages and the most impactful stages in order to identify optimization and improvement areas for technology and product development.
- Perform **sensitivity analyses** regarding the influence of the **wind plant lifetime** and of **different end of life treatments of blades** on the environmental profile of the Pauillac wind plant.

DATA

- Primary data: VALOREM, suppliers
- Secondary data: literature, generic data of Ecoinvent database

LIFE CYCLE STAGES

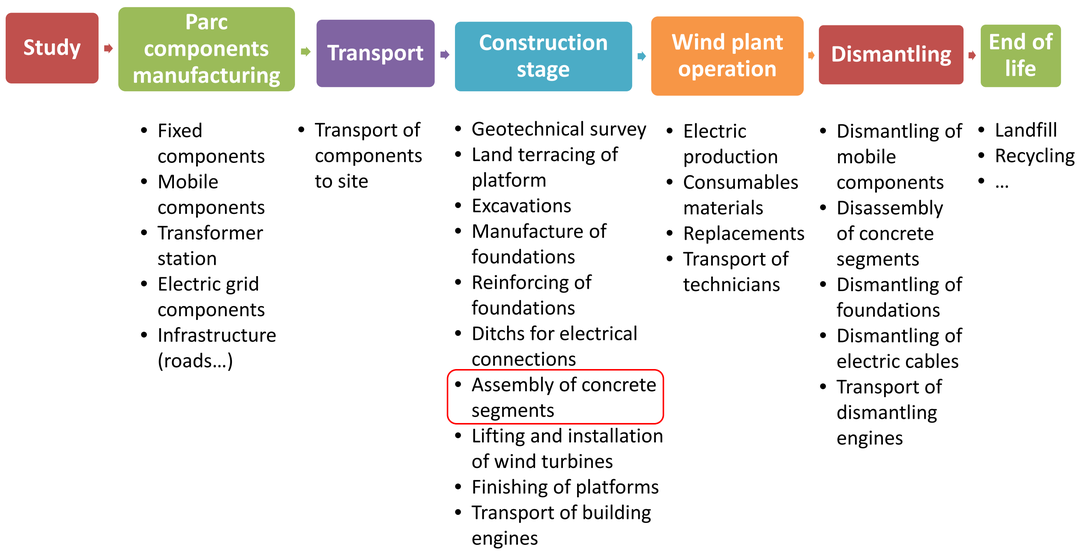

Figure 1: Life cycle stages considered for assessing the environmental impact of the wind plant

Functional unit : Deliver 1kWh of electricity to the electrical grid

Results

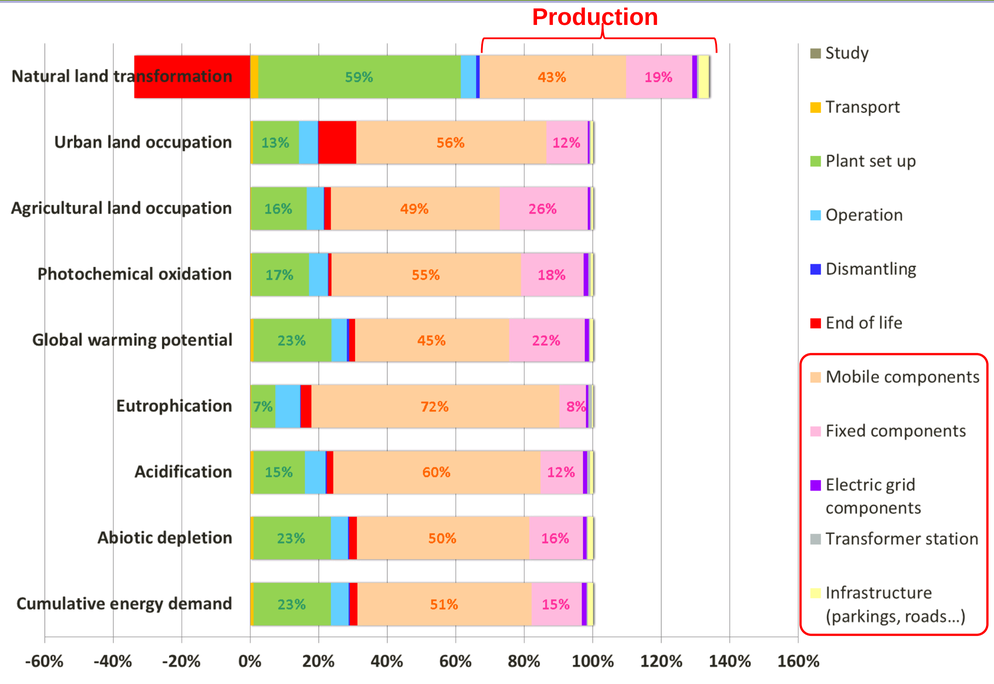

Figure 2: Contribution of the main life cycle stages to impact categories where the production stage has been detailed

Sensitivity analysis

Table1: Comparison of environmental impacts and quantitative indicators in relation to the lifetime of the plant

Impact category	Unit	Lifetime		Change (%)
		20 years	40 years	
Cumulative energy demand	MJ	1.849E-01	1.458E-01	**21**
Abiotic depletion	kg Sb eq	8.502E-05	6.684E-05	**21**
Acidification	kg SO_2 eq	5.354E-05	4.489E-05	**16**
Eutrophication	kg PO_4 eq	4.014E-05	3.657E-05	**9**
Global warming potential	kg CO_2 eq	1.177E-02	8.874E-03	**25**
Photochemical oxidation	kg C_2H_2 eq	3.985E-06	3.213E-06	**19**
Agricultural land occupation	m^2a	1.935E-04	1.496E-04	**23**
Urban land occupation	m^2a	1.447E-04	1.185E-04	**18**
Natural land transformation	m^2	1.647E-06	1.211E-06	**26**
Energy Payback time	**years**	**1.03**	**0.81**	**21**
Energy Intensity	**kWh used/kWh produced**	**0.051**	**0.040**	**22**
CO_2 Intensity	**g of CO_2/kWh produced**	**11.77**	**8.87**	**25**

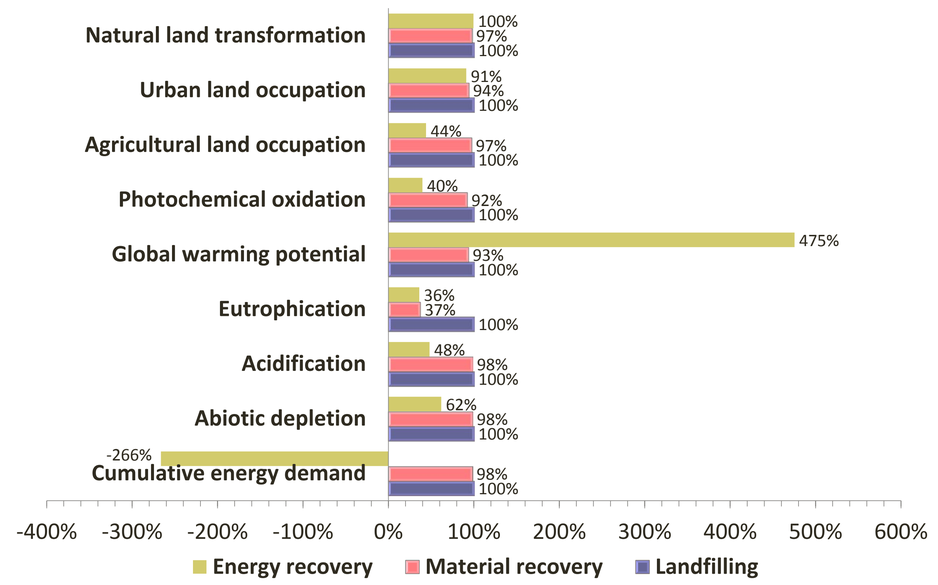

Figure 3: Comparison of the effects of considering different scenarios of blade end-of-life

Conclusions

Main results

- For each impact category investigated, the **production stage** of the different components of the wind plant, and more precisely the production of the **moving parts**, is the stage that **shows the most impacts**.
- Secondary impacts come from the **construction stage**, with strong impacts linked to the building of the **foundations.** This is mainly due to the mass of the corresponding components.

Sensitivity Analysis

- An increase of the **life time** from **20 to 40 years** leads to a **20% decrease** of results
- For the three **end-of-life** scenarios of **blades**:
  - No significant difference observed between the materials recovery and the landfill approach.
  - In the case of energy recovered from burning: evident positive impact on the cumulative energy demand, however impact on global warming is 4 times higher compared to the reference scenario (landfill).

Quantitative indicators

- The hypothesis on the life time of the plant showed a strong influence on the results ➔ decrease of 21% is observed for the Energy Payback Time indicator

References

1) *Afnor, NF EN ISO 14040: Environmental management: Life cycle assessment. Principles and framework*
2) *Afnor, NF EN ISO 14044: Environmental management: Life cycle assessment. Requirements and Guidelines*
3) *Crawford, R., "Life cycle energy and greenhouse emissions analysis of wind turbines and the effect of size energy yield", Renewable and Sustainable Energy Reviews, vol.13, pp.2653-2660, 2009.*
4) *Ardente, M. Beccali, M. Cellura et V. Lo Brano, "Energy performances and life cycle assessment of an Italian wind farm", Renewable and Sustainable Energy Reviews, vol. 12, pp. 200-217, 2006.*