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# Carbon footprint assessment of a wind power plant in Brazil: enhancing product value and life cycle management at Copel


**Companhia Paranaense de Energia - COPEL**

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## Introduction

At Copel, a Brazilian electric power and telecommunications company, we assessed the **carbon footprint of a wind power farm** under construction in Rio Grande do Norte - Brazil.

## Wind farm specifications:

- Nº of wind turbines: 149
- Wind turbine rated power: 2.1 MW
- Installed capacity: 313 MW
- Turbine model: WEG AGW 110/2.1
- Investment: R$ 1.7 bi (~US$ 550 mi)
- Tower height: 120 m (concrete)
- Rotor diameter: 110 m
- Project capacity factor: 54% (P50)


## Assumptions:

- Lifespan: 20 years
- Downtime: 10%

## Methodology:

- ISO 14067[1]
- GHG Protocol[2]
- Brazilian GHG Inventory[3]
- Ecoinvent
- As the guidelines presented on the International EPD System, the recycling process was not credited on the emissions[4]. In the EDP system, any recycling should be accounted in the emission factor of the materials. However, most of the recycling was not considered in the emissions factors, as the databases available in Brazil are limited.

## Results and Discussion

The life cycle stages were: Construction, Maintenance and Operation, and Decommissioning. The emissions from each stage are charted in Figure 1.

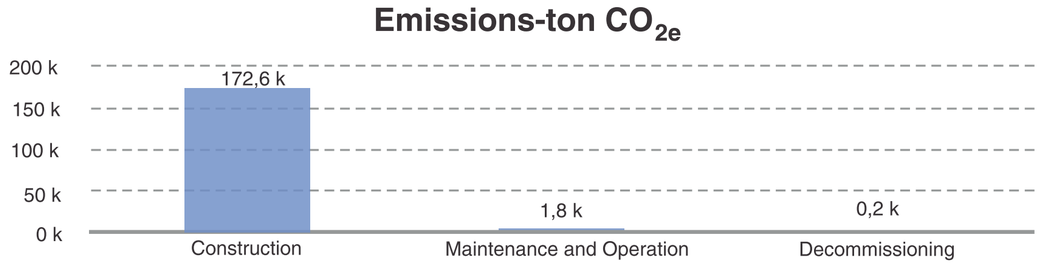


*Figure 1. Emissions from each stage*

The carbon footprint assessment showed a **total of 174,600 ton of CO2e** or **6.55 g CO2e/kWh**. The carbon footprint for each material is summarized in Figure 2.

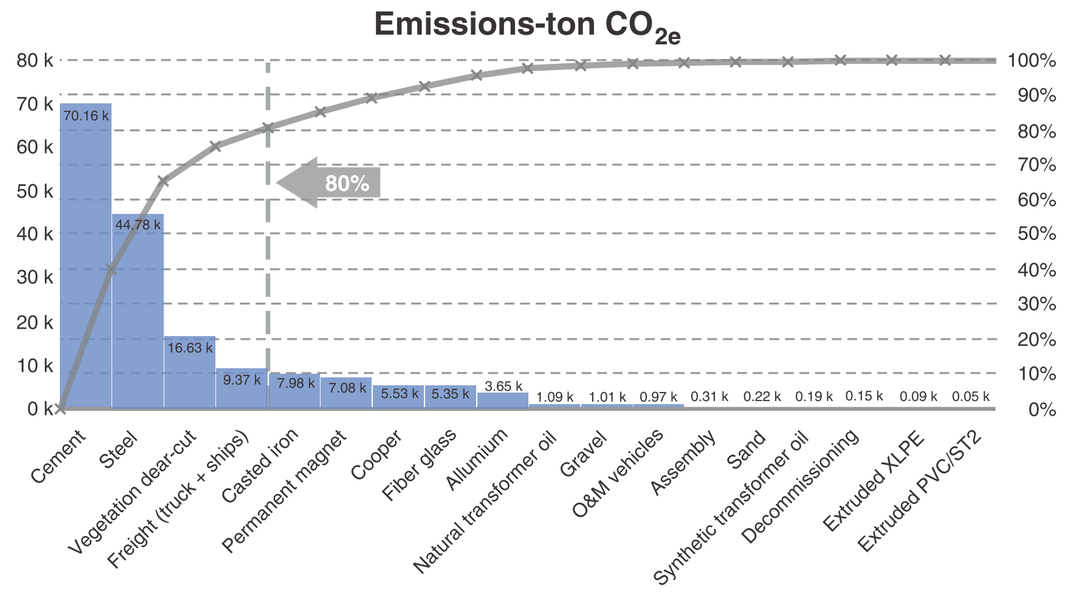


*Figure 2. Pareto chart plotting the emissions.*

Most of the emissions comes from cement and steel, together they sum up more than 60% of the total emissions. However, the most astonishing result, considering that the project is located in an area of shrub vegetation region, is that the third most representative emissions comes from **vegetation clear-cut**, needed for road access and wind turbine foundation (see Figure 3).

*Figure 3. Road access and tower foundation.*

## Vegetation clear-cut and sensitivity analysis

In Figure 4 the vegetation clear-cut was hatched over a satellite image and over a vegetation type aerial view. The vegetation hatched in yellow in the right figure is a type of shrub vegetation (caatinga – see Figure 5) while the region in brown is predominantly dunes.

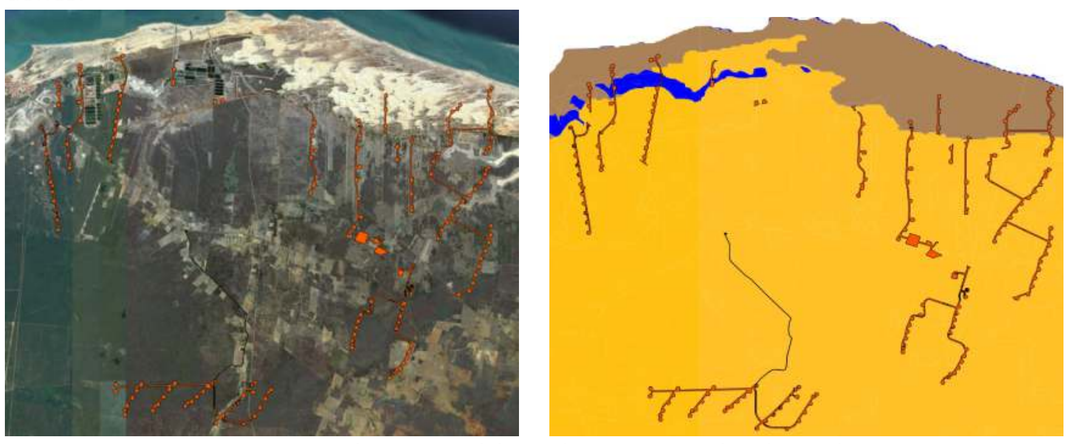

*Figure 4. Vegetation clear-cut on delimited areas (orange hatch). Each image is about 15km x 15km (9,3 mi x 9,3 mi)*

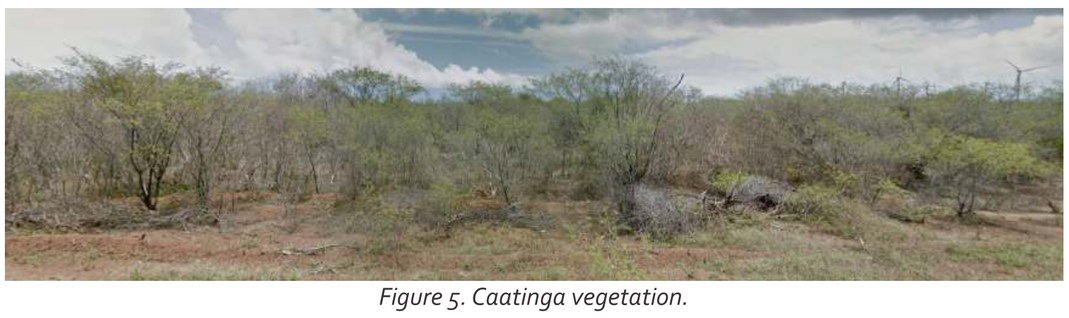

*Figure 5. Caatinga vegetation.*

As comparison, we conducted a sensitivity analysis, using the same wind farm configuration, but in other biomes. The result is represented in the table below:

| | Current Location | Atlantic Forest | | Amazon Rain Forest | | Cerrado | | Pampa | |
|---|---|---|---|---|---|---|---|---|---|
| Emissions (tons) | 16,626 | 134,326 | ↑708% | 216,450 | ↑1202% | 43,578 | ↑162% | 13,165 | ↓21% |
| g $Co_{2e}$/kWh | 6.55 | 10.96 | ↑67% | 14.04 | ↑114% | 7.56 | ↑15% | 6.42 | ↓2% |

As showed above, the emissions from vegetation clear-cut can be substantially greater depending on type and amount of vegetation. If it was constructed in the Amazon Rain Forest we would expect at least to double the emissions per kWh.

## Creating Value Through Carbon Footprint Assessment

At Copel, we assessed the carbon footprint in order to identify hotspots and issue recommendations for future wind power projects. However, we also aim to increase our energy value when sold in the free market. We intend to achieve this by **empowering our clients with information from our emissions**, this way they will have the opportunity to make informed decision when acquiring electricity.

## Conclusions

- Emissions from clear-cutting trees are significant even in places where the vegetation is dominated by shrubs. This is a main hotspot on wind farm construction. The amount of cement and steel used in the construction is not as flexible as the location of the towers.
- Wind turbines are a renewable clean source of energy, but if the wind farm's project aim for the lowest possible $CO_2$ emission, the place where the tower will be constructed must be taken in consideration.
- Supplier collaboration is essential to carbon footprint assessment, as much as in any Life Cycle Assessment.

## Acknowledgement


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## References


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[4] EDP System. General Programme Instructions for the EDP System. Version 2.5. 2015.