INDUSTRIAL GROWTH AND QUALITY ASSESSMENT OF *NANNOCHLOROPSIS OCEANICA* CULTIVATED OFF-THE-GRID

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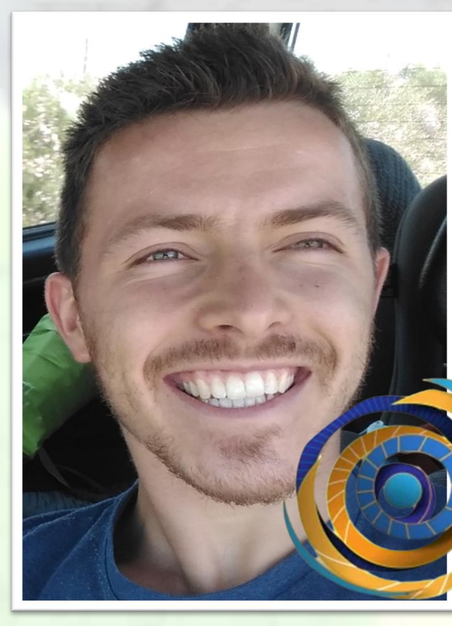

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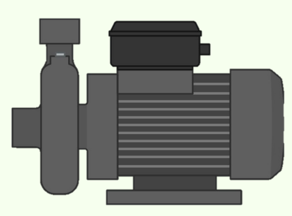
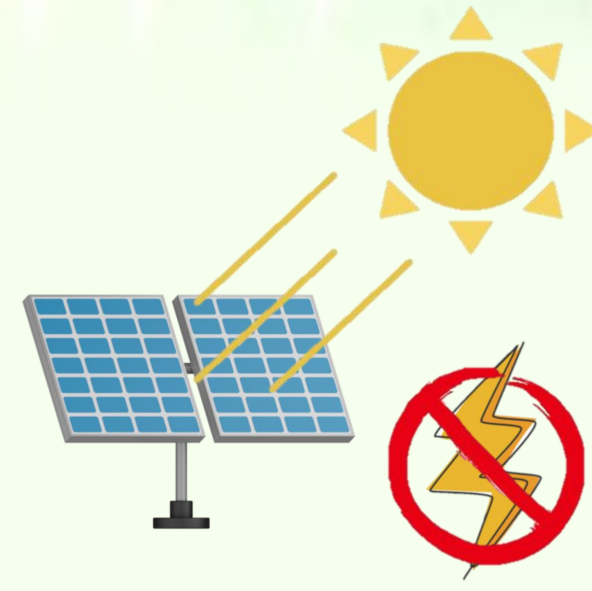
INTRODUCTION

Circulation pumps are one of the main energy-consuming equipments of microalgae industrial production in tubular photobioreactors (TPBRs)[1,2]



- Achieve nutrient mixing
- Improve gas-liquid mass transfer
- Increase light availability
- Prevent culture settling

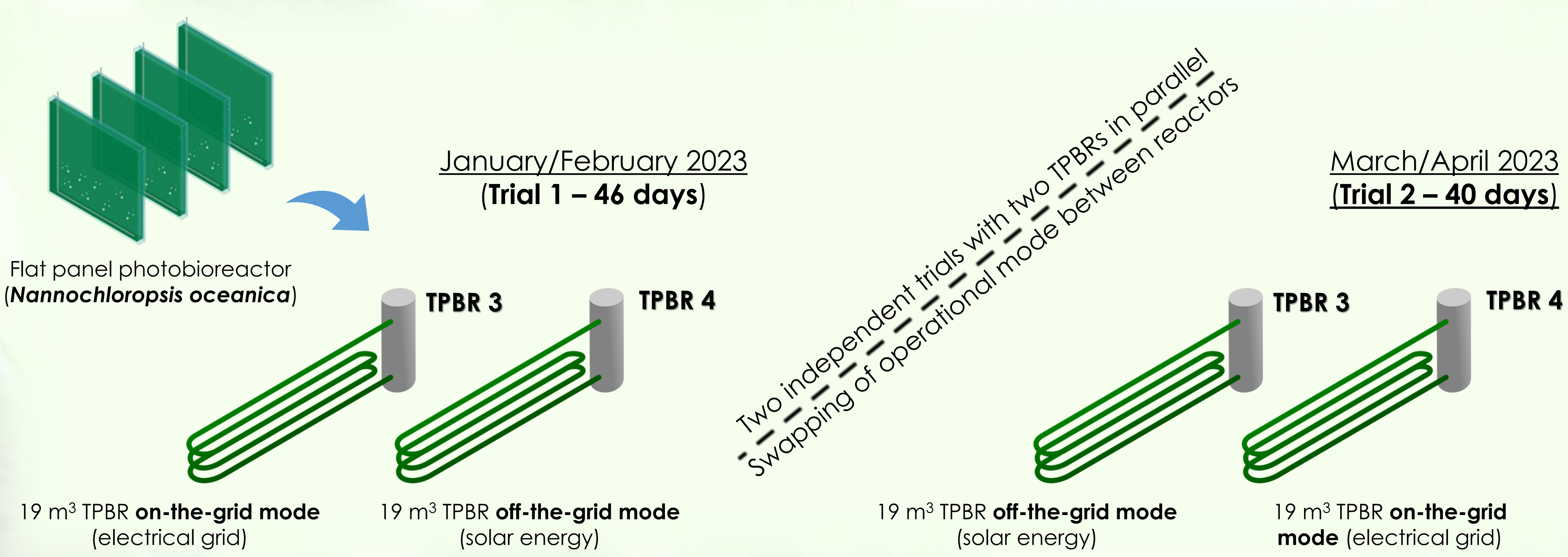


To decrease grid energy consumption associated with pumping, and thus increase the sustainability along the microalgae production pipeline, Necton S.A. developed an "off-the-grid" system able to run the TPBRs only on photovoltaic (PV) energy

Objective:

Compare *Nannochloropsis oceanica* production efficiency and culture quality in an industrial TPBR running on solar energy (off-the-grid) against an industrial TPBR running on electrical energy (electrical grid)

METHODOLOGY



Daily monitoring:

☼ Growth and productivity (through optical density converted to g/L and g/L/d of dry weight [DW])
☼ Chlorophyll *a* fluorescence (OJIP; Fv/Fm)
☼ Microbiology (PCA + 3% NaCl)
☼ Microscopic observations
☼ Temperature
☼ pH
☼ Turbidity

RESULTS AND DISCUSSION

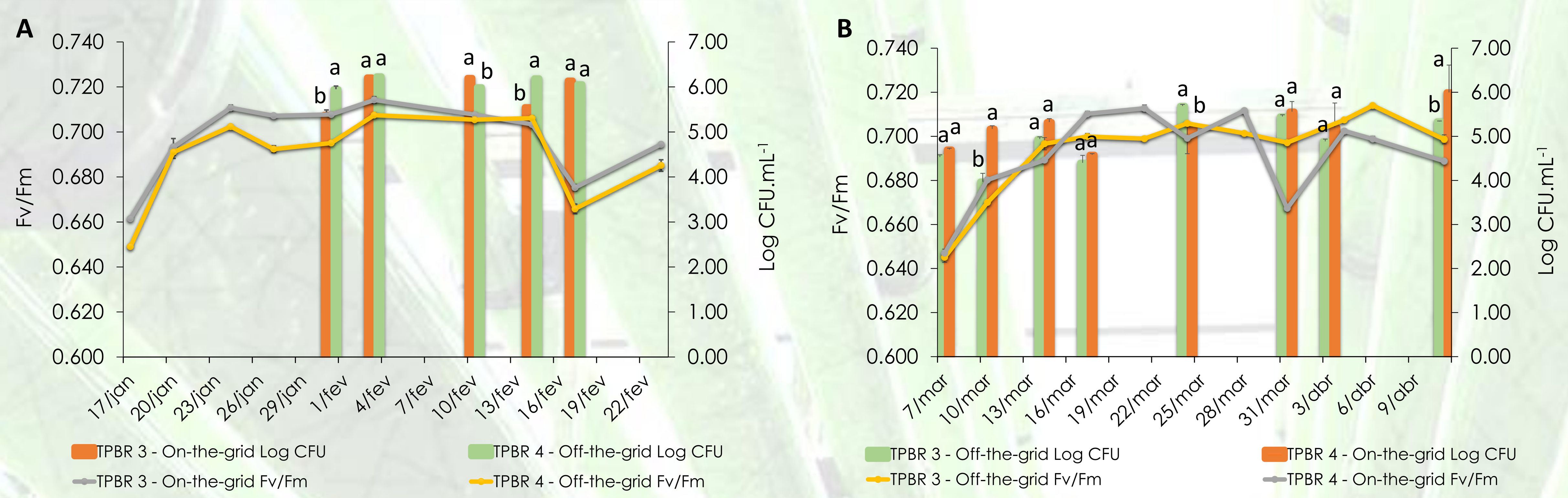


Figure 1: Chlorophyll a fluorescence, represented as Fv/Fm ratio (lines - left axis), and microbial counts, represented as Log CFU.mL^{-1} (bars - right axis) of *N. oceanica* cultivated in two different operational regimes. (A) Trial 1; (B) Trial 2. Axis is cut for easier reading. Data points are shown as mean ± Std. Dev. of technical replicates (n = 3 for Log CFU.mL^{-1} and n = 2 for Fv/Fm). Different letters represent significant differences on the microbial counts for each day (independent samples T-test, p<0.05).

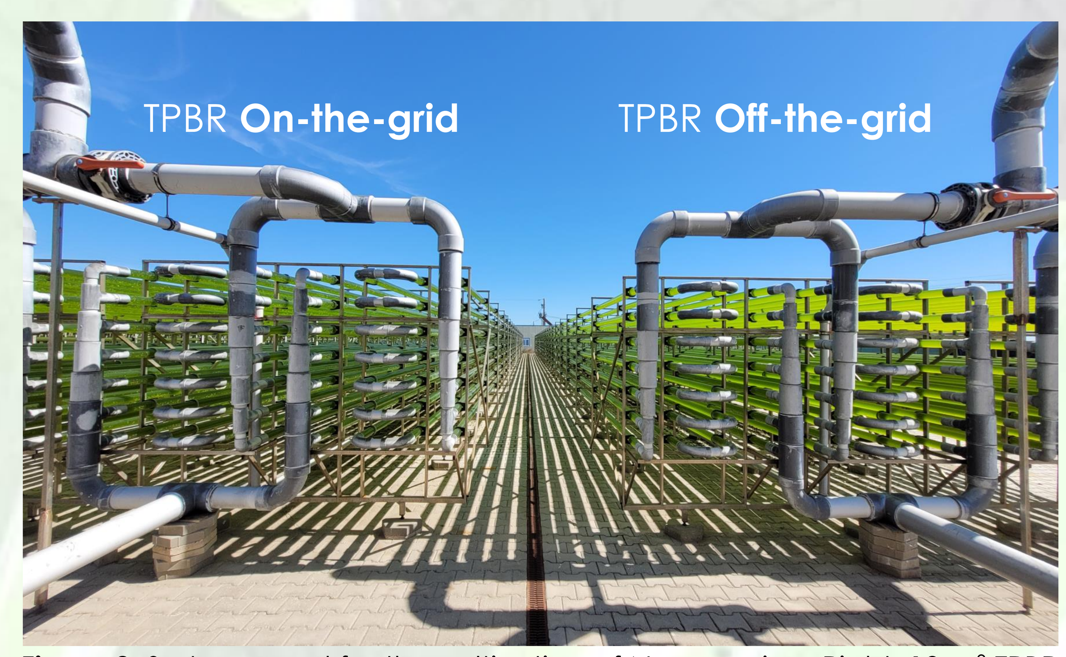


Figure 2: Systems used for the cultivation of *N. oceanica*. Right: 19 m^3 TPBR 4 off-the-grid; left: 19 m^3 TPBR 3 on-the-grid (**Trial 1**). On the on-the-grid mode, pumps work at constant speed using grid energy (normal regime). On the off-the-grid mode, pumps are stopped during the night and start increasing their speed after sunrise. Then, they work at normal speed when enough irradiance is available, but slow down when the photovoltaic production reduces (e.g., due to weather conditions), turning off again before sunset.

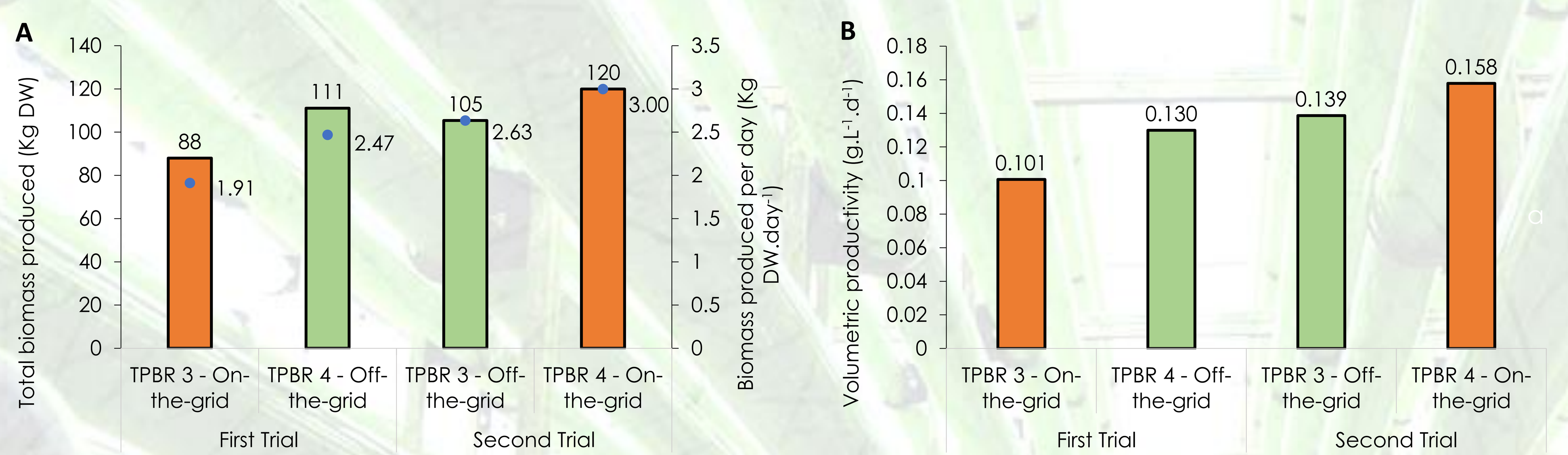


Figure 3: Estimation of: (A) total biomass produced (Kg DW) (bars - left axis) and biomass produced per day (Kg DW.day^{-1}) (blue dots - right axis) and (B) volumetric productivity (g DW.L^{-1}.d^{-1}) of *Nannochloropsis oceanica* cultivated in two different operational regimes - on-the-grid and off-the-grid. Both trials (Trial 1 – 46 days and Trial 2 – 40 days) are represented showing the swap of operational mode between reactors.

- ✓ **Absence of differences** on overall **total bacterial counts** and on the **Fv/Fm ratio** between operational modes for both trials
- ✓ **Volumetric productivity** not considerably affected by the swap of operational modes
- ✓ **Total biomass produced** and **productivity** always **higher** for TPBR 4 and for Trial 2 due to higher solar irradiance incidence on this reactor and higher growth of *N. oceanica* in Spring months, respectively

CONCLUSIONS

- ➢ Productivity, fluorometry and microbiology quality data suggest the **absence of differences** between the two tested operation modes
- ➢ The **off-the-grid operational regime** does **not** seem to be **detrimental** for *N. oceanica* cultivation

TAKE HOME MESSAGE

The **off-the-grid operational mode**, based on solar energy, can be a **more energy-sustainable** and **cost-effective** option for industrial microalgae production in TPBRs

REFERENCES:

1. Acién Fernández, F. G., Fernández Sevilla, J. M., & Molina Grima, E. (2018). Costs analysis of microalgae production. In *Biomass, Biofuels, Biochemicals: Biofuels from Algae*, Second Edition.
2. Norsker, N. H., Barbosa, M. J., Vermuë, M. H., & Wijffels, R. H. (2011). Microalgal production - A close look at the economics. In *Biotechnology Advances* (Vol. 29, Issue 1)
3. Shekh, A., Sharma, A., Schenk, P. M., Kumar, G., & Mudliar, S. (2022). Microalgae cultivation: photobioreactors, CO2 utilization, and value-added products of industrial importance. In *J. Chem. Technol. Biotechnol.* (Vol. 97, Issue 5)

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