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A model for the simulation of energy balance for microalgae introduction in wastewater treatment plants

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Appendix - Sensitivity analysis

A sensitivity analysis was conducted to test the robustness of the solution. All parameters related to the microalgae were tested (CO$_2$ absorption by microalgae, NH$_4$ reduced by microalgae, P reduced by microalgae, Minimal quanta required to liberate O$_2$ for sunlight) as well as the observed yield for bacterial biomass ($Y_{obs}$).

Each parameter was individually changed to +/- 50% of its original value and the effect on calculated CO$_2$ emission, heat and electricity consumption and biomass concentration was examined for each WWTP. A surface factor of 12 was used for the sensitivity analysis since the impact of the parameter on the result increases with the surface factor. The results are shown in Figures 1-3. These results were insensitive to changes in ability of the microalgae to remove P and N, as demonstrated in Figure 1 a and b. Only the net electricity consumption for each WWTP shows a change of more than 1% as the N reduction capability of the microalgae is varied between -50% to +50%. The parameters $Y_{obs}$ and CO$_2$ absorption ability of the microalgae have a large impact on

![Figure 1 a-b Sensitivity analysis for ability of microalgae to reduce P (a) and N (b). Each parameter is changed by ±50% and the resulting change in the calculation outputs is shown (outputs that did not change were not included in the figure). Outputs whose results are indistinguishable from each other are grouped together.](image-url)
some of the calculated outputs. In particular, the CO₂ absorption by the microalgae has a large impact on CO₂ emissions from the plant. These emissions also depend on operating conditions, as shown in [1] where they varied from 1.5 to 1.9 gCO₂ g⁻¹ microalgae depending on light wavelength.

The observed yield of the bacteria biomass mainly affects the biomass concentration in the basin. The bacteria make up a majority of the biomass and it is therefore not surprising that changing the Y_{obs} has an almost 1:1 effect on the biomass concentration.

The oxygen yield per microalgea and minimal quanta need to liberate O₂ are the two parameters with the largest influence on the calculations. The quanta needed to liberate O₂ can be particularly difficult to determine since it is affected by the operating conditions. If biomass concentration in the reactor becomes too high and/or the stirring is not sufficient the quanta need would be expected to increase since more sunlight will be dissipated on its way to the microalgae. If the quanta need is too high the microalgal population may become too small to have an impact on the system. However, it should
be noted that according to the calculations the biomass concentration in the basins is on the same order as those usually found in photobioreactors [2].

Figure 3 a-b Sensitivity analysis for the microalgae yield per O₂ (a) and the quanta need to liberate O₂ for sunlight. Each parameter is changed by ±50% and the resulting change in the calculation outputs is shown (outputs that did not change are not shown). Outputs whose results are indistinguishable from each other are grouped together

References
