

Thesis English Summary

This work falls within the task 6 of the Green AlgoHol ANR project (Challenge "Energy, clean, safe and efficient" end 2015- 2017) which is coordinated by the Center of Study and Valorization for Algae (CEVA, Pleubian, 22). The project started in January 2015 and aims to study the feasibility and sustainability of the production and processing of macroalgae as a feedstock for a bio-refinery. The main valorization path that will be studied is an energy recovery path of the algal biomass through the production of ethanol. Five research institutes are working in this project: CEVA, CNRS-CERMAV, IFPEN, INRA-LBE and ISCR. The LBE is in charge of the environmental assessment of the studied sector by the Life Cycle Analysis methodology (LCA). This thesis focuses on two aspects: the LCA study of the Green AlgoHol project and improvement of the methodology.

LCA is a methodology standardized ISO for assessing the environmental impacts of a product, a process or a system. This assessment is based on Life Cycle Inventory (LCI) of any system that identifies all of emissions to the environment and possible consumption of resources (for a total of around 1,800 substances). LCIs show many sources of variability due to the diversity of systems, the model uncertainties, the variations of the real world ... Following the construction of LCI, emissions are translated in terms of impact on the environment through a set of impact categories: climate change, depletion of fossil resources, acidification, human toxicity ... Different methods of calculation (ILCD, ReCiPe, CML, Eco-indicator ...) can be used to determine the results on each impact; each method of calculation is a set of impact categories and suggest a way to characterize these categories. LCA reduces the complexity of an 1800-dimensional problem of systems comparison (number of substances emitted or taken from the environment) into a 20-dimensional problem where each dimension has an environmental meaning. Each impact category represents on a more or less exhaustive manner the original LCI and its variability.

Analyzing 20 impact categories proposed by each methods remains an important work and communication of those results is not easy. Several approaches are possible. LCA practitioners often reduce the number of impact categories to be interpreted according to the consistency of impact categories with the goal and scope of the study (for example: a set of categories defined by the Environmental Product Declaration) or environmental issues related to the field of activity of the systems studied (climate change for the transport sector). This selection of impact categories is then a relatively subjective selection. Selected impact categories may not reflect the variability between LCI and the withheld information used to make comparisons could not really be relevant.

In scientific literature, several publications reduce the complexity of comparisons (in terms of number of impact categories to interpret) by performing a Principal Component Analysis on impact categories results. This method makes it possible to aggregate categories according to their correlations.

This thesis proposes to develop a methodology for selecting impact categories that best reflects LCI variability. Automatic identification of relevant and not redundant impact categories will propose guidelines on the choice of categories to study according to the information they carry about emission variability of the systems studied.