Project EnerBioAlgae (SUDOE): Fluorescence spectra techniques for the control of phytoplankton cultures and monitoring of wastewater parameters

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1 Background & Motivations

There is a significant interest in alternative renewable energy sources due to the global increase of energy demands and the daily decrease of fossil fuel resources. Microalgae can provide various types of products such as the methane produced by the anaerobic digestion of biomass of algae, biodiesel from microalgae lipids and bio-hydrogen. Biodiesel production techniques are known for more than 50 years (Meher et al., 2006) and the utilization of microalgae for biodiesel dates back to the 80's, but are now with the energy and ecological crisis when globally it is considering as a serious alternative to fossil fuels. Briggs (2004) indicates that from 1978 to 1996, the Department of energy of the USA, under the National Renewable Energy Laboratory (NREL), known as "aquatic species program", developed research to identify the microalgae with high content of oils, which can be cultivated in order to produce biodiesel. The results of this program established that some species of microalgae are ideal for the production of biodiesel, due to its high oil content (more than 50 per cent) and its rapid growth. However, some problems related mainly to the production costs were considered as hard to solve. To date the knowledge provided by NREL has been the most ambitious in the production of biodiesel from microalgae. However, there are currently many countries trying to improve the microalgae cultivation techniques in order to make them simpler and more profitable. To date the knowledge provided by NREL has been the most ambitious in the production of biodiesel from microalgae. However, there are currently many countries trying to improve the microalgae cultivation techniques in order to make them simpler and more profitable. According to the www.oilgae.com portal, the oil production in microalgae is greater than in traditional oil seeds. In this respect, estimates made by the company Bio Fuel System (BFS) indicate that soy, rapeseed and palm oil produced 50 m^3 km^{-2} $year^{-1}$, 100 to 140 m^3 km^{-2} $year^{-1}$, and 610 m^3 km^{-2} $year^{-1}$, respectively; while the microalgae can produce 10000 to 20000 m^3 km^{-2} $year^{-1}$.

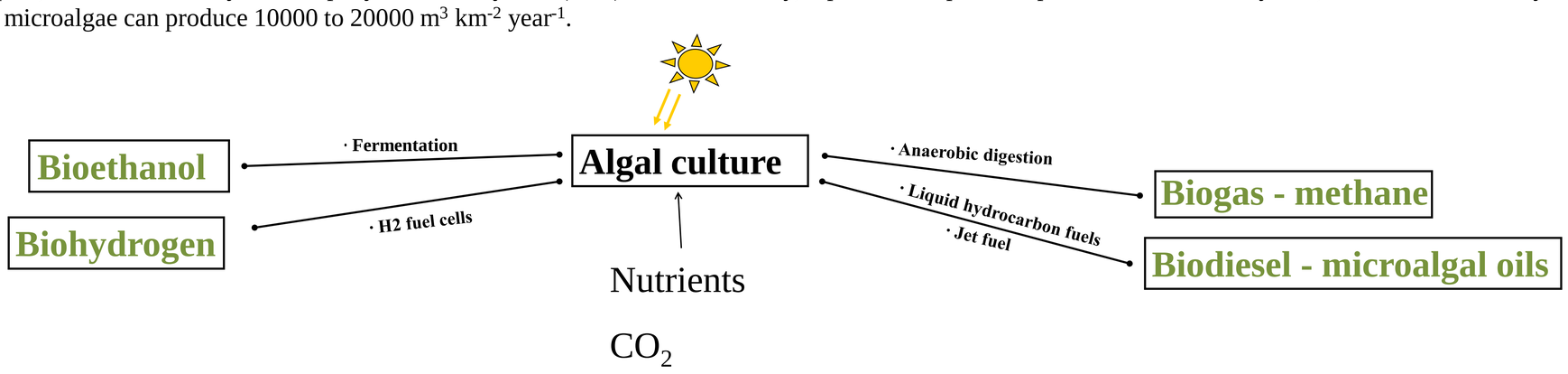
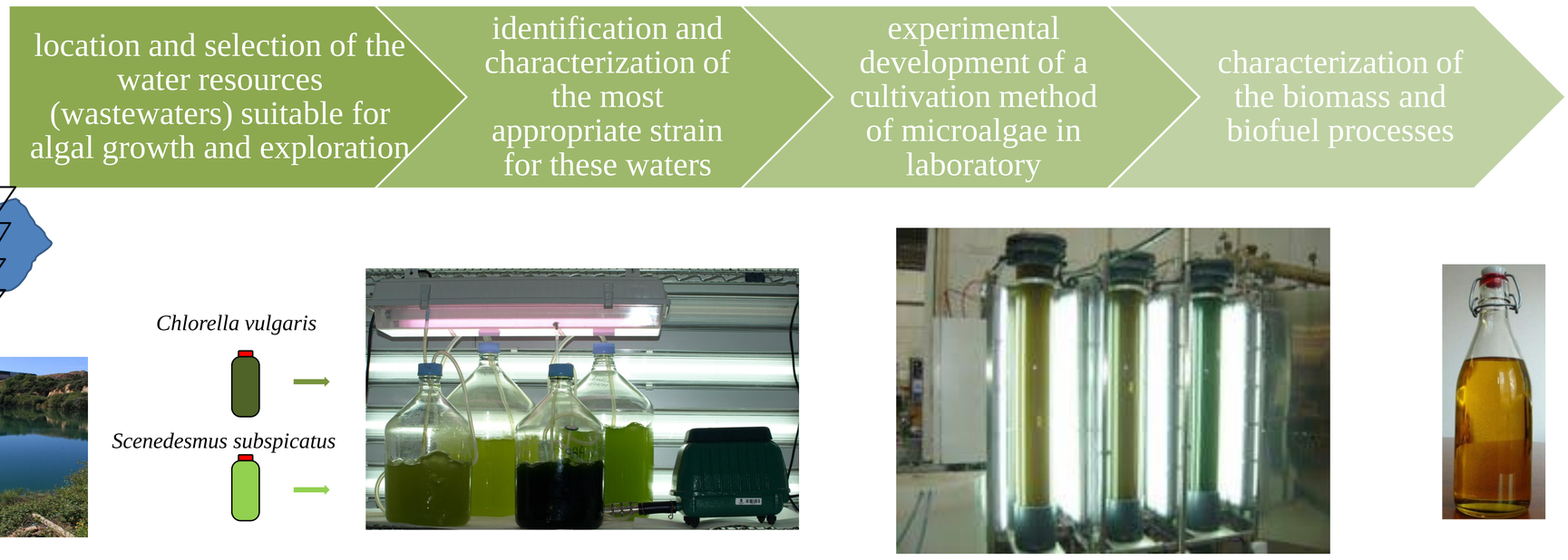


Fig. 1. Microalgae as a source of energy

2 The project

EnerBioAlgae is presented as a structuring initiative covering a subject strategy for the integral development of the SUDOE ("Espacio Sudoeste Europeo") zone and whose purpose is energy performance through interventions of environmental recovery in degraded water areas rich in microalgae. The technical, economic and environmental viability will be tested through a pilot project in two spaces of the SUDOE territory with great potential for exploitation. The entire process is enhanced by the development of specific technologies and their implementation. This ambitious purpose will bring results in the optimization of the performance of the production of biofuel process at the same time allowing initiating processes of environmental recovery. This includes the developing of clean and efficient energy conversion processes to respond to present and future technological and environmental demands, demonstrating the technical and economic viability. The cultivation of microalgae and their conversion into biofuels is a feasible solution to the uncertain future of energy. EnerBioAlgae is a proposal that integrates the protection and conservation of the environment, combating climate change, diversification of sources of energy supply, the development and exploitation of alternative energy sources. The work plan of the EnerBioAlgae project involves the following steps.



3 SFS and NNs techniques as an implementation for on –line monitoring of the microalgae cultures

SFS ("Spectral Fluoresence Signature") is the sum of the emission spectra in all the spectra region for a sample in different wavelengths of excitation. SFS technique in this project was applied in this project for the analysis of the cultured microalgae and water quality using the fluoresence analyser INSTAND-SCREENER developed by Laser Diagnostic Instruments AS. INSTAND-SCREENER permits wavelength scanning in two modes, one in UV and another in VIS. Figure 2 presents the advantages of this method for the monitoring of the microalgae cultures while Figure 4 an example of a spectral signature of the microalgae *Chlorella vulgaris*.

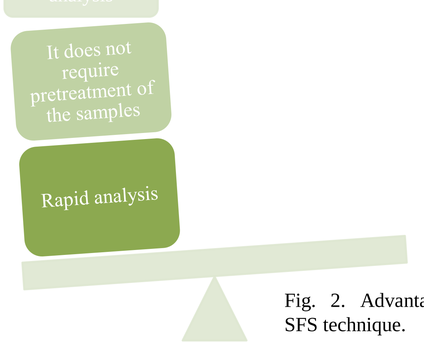


Fig. 2. Advantages of the SFS technique.

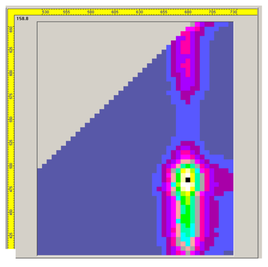


Fig. 3. Example of a spectral signature in VIS of the microalgae *C. vulgaris*.

In this project Artificial neural networks (ANNs) are going to develop in order to follow the growth rates and state of the microalgal culture as well as the quality of the wastewater used as a medium. ANNs are algorithms implemented in the form of software or electronic model, inspired by statistical methods. ANNs are nonparametric methods, in the sense that do not require a default architecture, so neural networks constructed their own model-based training, learning and change. The use of neural networks is an increasing use in the classification of optical parameters from data of radiometers, allowing model operationally complex algorithms hardly implementation-tables in another way. Currently algorithms to the study of this type of waters using remote sensing are based on this kind of neural networks (e.g. González Vilas et al., 2011), trained and validated with in situ data (e.g. Spyrakos et al., 2011).

4 Conclusion

The growth of energy demand and the need to preserve the environment and ensure sustainable development, forcing the search of new energy renewable sources. The use of microalgae as a source of energy via biomass for energy use or by conversion into biofuels presents excellent prospects for the future, with competitive advantages. However, although the number of experiences and projects is increasing, progress in the research are slow and prevails the need for further scientific work oriented to the development of more efficient technology. Get the maximum return of energy production on an industrial scale, requires more investment in research applied to various fields of technology and supported by pilot experiences with demonstrative character.
EnerBioAlgae responds to these needs at the time that contributes to environmental improving the quality of polluted water. The use of new techniques of analysis in continuous as the one presented in this work with the FSS system combined with neural classification algorithms allows us to make progress in the techniques of instrumentation and analysis in this field.

Acknowledgments

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