

CASE REPORT

CONTROL SYSTEM FOR PHOTOBIOREACTORS

This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF.



CONTROL SYSTEM FOR PHOTOBIOREACTORS

Summary

>Of the technology and its application area(s).

One of the most important challenges in the actual socio-economic situation is to produce sufficient quantities of biofuels, which can limit the consumption of fossil fuels and lower greenhouse gasses emissions, without competing with food production. One of few options for producing sufficient quantities of biofuels is the use of algae biomass. Algae can growth continuously 5–10 times faster than traditional crops, with no lands suitable for plant raising competition. The production rate per area unit is 20–50 higher than other plants. The actual production of algae biomass with already developed technology is still negligible the production costs are 5–10 times to high and algae biofuel are still non-competitive. Because of the great potential of algal technologies many development groups were established around the world in the last five years with the focus on economically efficient and scalable solutions for algae biomass production.

Technology

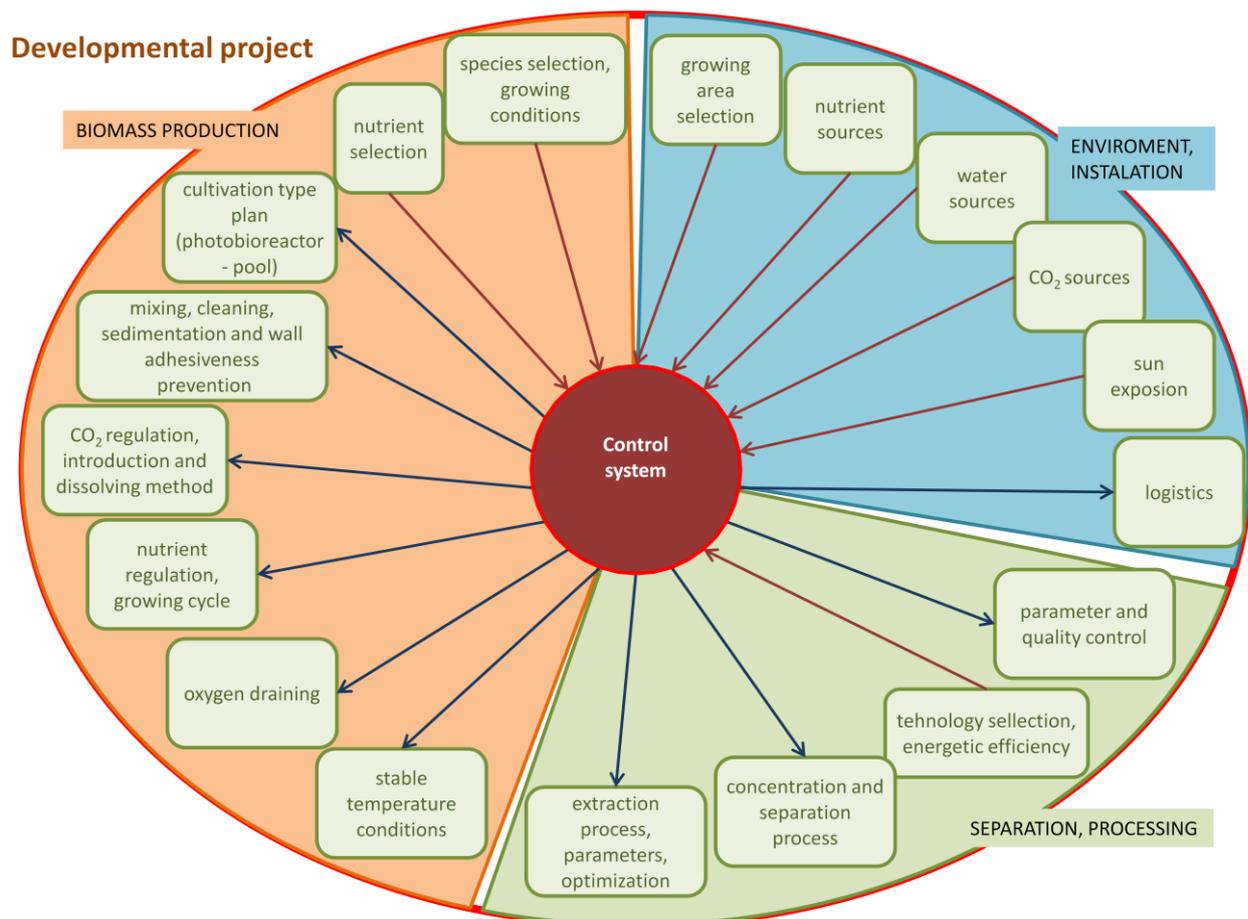
>Easy understandable description of the technology with pictures when applicable.

For conducting basic research of various algal cultures in moderately large volumes under realistic conditions, we need a suitable process control system. It can provide a stable environment in which optimal biomass growth can be reached. Because of huge biodiversity of algae species, their specific physiology and ecology and different growing techniques every single PBR setup needs its own customized control system.

AlgEn is developing an integrated and fully automated control system which consist on regulation of CO₂ concentration, regulation of mixing (permanent flow and wave generation) and measurement of all necessary process variables (pH, temperature, optical density). The control system will facilitate shared measurements of nutrients concentrations using a system of Ion selective Electrodes (one analytic chamber for many PBRs) and shall provide logging of all measurements and controlled values for further analysis. The control system could also control the media flow trough the subsystem for biomass concentration and extraction. The control system will be implemented using open technologies enabling further extensions, modification and customization of experimental processes. We expect to use the EPICS (Experimental Physics and Industrial Control System) as the control system framework – this is a completely open (and open source) system. It will consist of mostly commercially available of-the-shelf components (pumps, valves, sensors, and electronics).

The development of control system is relatively isolated phase in the concept of development or installation of algae bio-production system. Specifications for such subsystem are easily definable;

interfaces to other part of the system are usually well defined. The development of the subsystem control system development can be often parallel to other work. The profile of control system developers is slightly different of photobioreactor developers and control subsystem development is often out of their main competences. The bottom figure illustrate the number of problems which are included in a typical developmental project, therefore the independent outsourcing for control subsystem development is reasonable.



A well designed control system can be significant advantage in a developmental project. It's worth especially for common characteristic of control system such are data logging, alarming, user interfaces... - those parts of control system are in the case of specific development often forgotten or only superficially accomplished.

On the other hand the control system is very tightly connected with the functionality of the whole controlled system. Therefore is difficult to speak of common control system. Our model foreseen the production of a common stable system core which can be customized based on specific purpose. Most likely for every single application some part of functionality should be developed, however it can be done efficiently and in best quality based on a premanufactured platform.

The specificity of the photobioreactor control system in comparison with other bioreactors control systems is in controlling the light component of the process. Our control systems are additionally designed to

simultaneous control multiple photobioreactors in cost sensitive configurations. Technical alternatives for controlling the process which end product is 100 times cheaper than pharmaceutical products are proportionately moderate and the control systems for nutraceutical production are not really our competition.

The use of our control system in developmental implementation project has for the customer following benefits:

- specialized developmental team, with experience in control systems for photobioreactors,
- fast implementation,
- functionally rich and verified control system,
- vast possibilities of configuration, customization and system upgrade,
- the course of control system development in parallel with other development,
- fair methodology and project documentation,
- substantially lower own developmental costs.

Our product offer is based on selling already manufactured core control system with development of specific additional functionality, installation, system configuration and integration, testing and operational support.

Based on actual plans we estimated the average value of the project (at least in starting phase) on around 40000 €. Half of this will be the material costs for the system (sensors, computer equipment), the rest will be equally shared for customization, installation and configuration of the system and for the licensing for generic control system core.

Development stage

>In which stage of development does the technology exist today (e.g. prototype, proof of concept, ready for marketing, passed certain clinical trials or equivalent)?

- A preliminary design of the PBR and the control system which altogether consist of cca 150 controlled parameters has already been made.
- The PBR control system is in phase of prototyping.

Market/Opportunity

>Which are the possible commercial application areas of the technology?

>Short characterizing of these markets including competitors, total market size, market growth, and geographical spread.

>If possible, simple estimation of turnover the technology could yield in a couple of years.

Algal technologies have a big economic potential on different segments. Already implemented biomass production technologies are used in food and pharmaceutical industry. The installations are already

commercial, technology are well developed although with possibility for breakthrough with new solutions. This is not the primary focus of our company rather a potential market for gathering experience and partial realization of revenue.

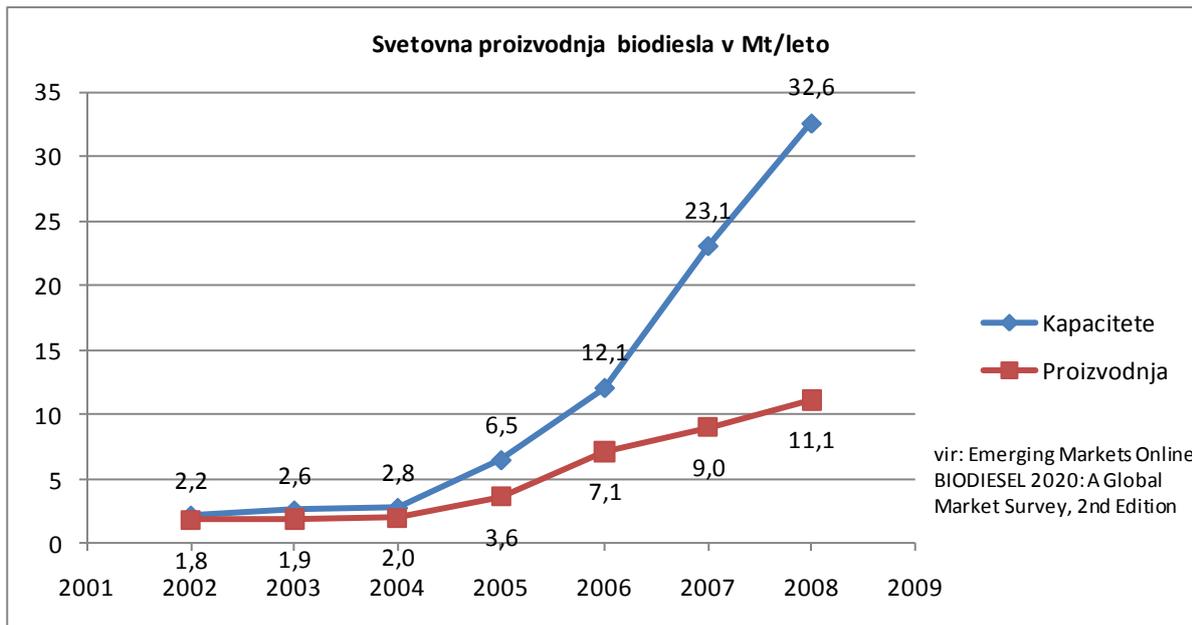
AlgEn primary focus is algal biomass production for energetic purposes. This field is interesting because of great potential of such applications: if there will ever be a significant relevance of biofuels in total mass of liquid fuels they will be algal and/or ligno-cellulose biofuels. Intensive research is undergoing on both fields, but there are no commercial solutions for efficient industrial scale use.

AlgEn market strategy is not oriented in production and selling of algal biomass but in engineering and system integration of such projects for industry applications. Until those kind of projects will reach the phase in which can be realized engineering of industrial projects, AlgEn will gather experience, knowledge and generate profit by selling services to research and development projects on field of algal technologies.

The plans of AlgEn is to acquire the basic competitive advantage with development of photobioreactor control system. The analysis of the potential market and competition shows, that we can efficiently promote our experiences, as in the moment of entering the market there is little or no competition. In many projects which include the control system the development of such system can be outsourced by a partner with special experiences. This is the segment in which AlgEn plans it's business opportunity. By the collaboration in developmental projects with the expertise on control system we can get in touch with the contents of the entire project.

In the beginning our target market segment are groups involved in development of photobioreactors and similar technologies (open ponds raceways and combinations). In the last three years the number of such groups increases significantly, from 0 to 100. The exceptional potential of algae technology on the field of biofuels caused the bloom of developmental projects in wide span.

It is a fact that biofuel world production capacities (bio-ethanol in both Americas and biodiesel mostly in Europe) already far exceed available sources of raw material. The producers of biofuels are therefore the most interested for use of algal biomass.



Diverse studies foresee the commercialization and production of biofuels different. In average in the next five years (till 2015) vast uses of algal technologies is estimated for production of high added value products (biofuels not included), only in years 2015–2020 wide use for low price end products is estimated. That is illustrated in a figure from market analysis Algae 2020 Study, Emerging Markets Online below:



There is a list of more than 100 companies and developers group that had at least on active project based on energetic use of algal biomass in 2009. We expect at least 20 potential customers or a 15% market share. Regarding the certain increasing number of developers groups in the next year the estimation is quite conservative. The Algal Industry Survey¹, a study accomplished in 2008 in 137 companies in Singapore find out that the control system is on the fourth place of critical problems, immediately after the

species selection, light usage and photobioreactor. In the same study the choice of the right growing system (photobioreactor or open pond) estimated as the most important element of algal industry (more than employees qualification, species selection and entering costs).

Beside big developmental groups we can enter also the market of small developers with a version of a control system. Such market exists (e.g. the publisher of the book Making Algae Biodiesel at Home¹ sold more than 1000 books) but it is cost sensitive. The decision of feasibility of such solution productisation will be taken only when the basic system development is finished.

The most likely alternative to implementation of our control system in a developmental project is an internal development within a project; it will be the most challengeable obstacle in the process of market development. The other potential alternative for a developmental group is the choice of solution of another developmental group. We would be positioned in such category too.

IP

>Is the technology protected by IP of any kind?

>If so, what is the status of the IP (priority date, in which countries has it been filed and/or granted)?

>What is the current IP strategy being pursued?

This specific technology for small scale PBR is not yet protected.

Contact Details

>Provide contact details to the responsible technology transfer manager or to the researcher when applicable.

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¹ David Sieg, Tram Nguyen, Making Algae Biodiesel at Home, Information Specialists, Corp., 2009, <http://www.making-biodiesel-books.com/>